Concrete

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Progress in Structural Concrete During 1926

Year Saw Notable Progress in Use of Concrete in the Structural Field—Some Outstanding Structures Completed in 1926—Advances Made in Use of Quality Control

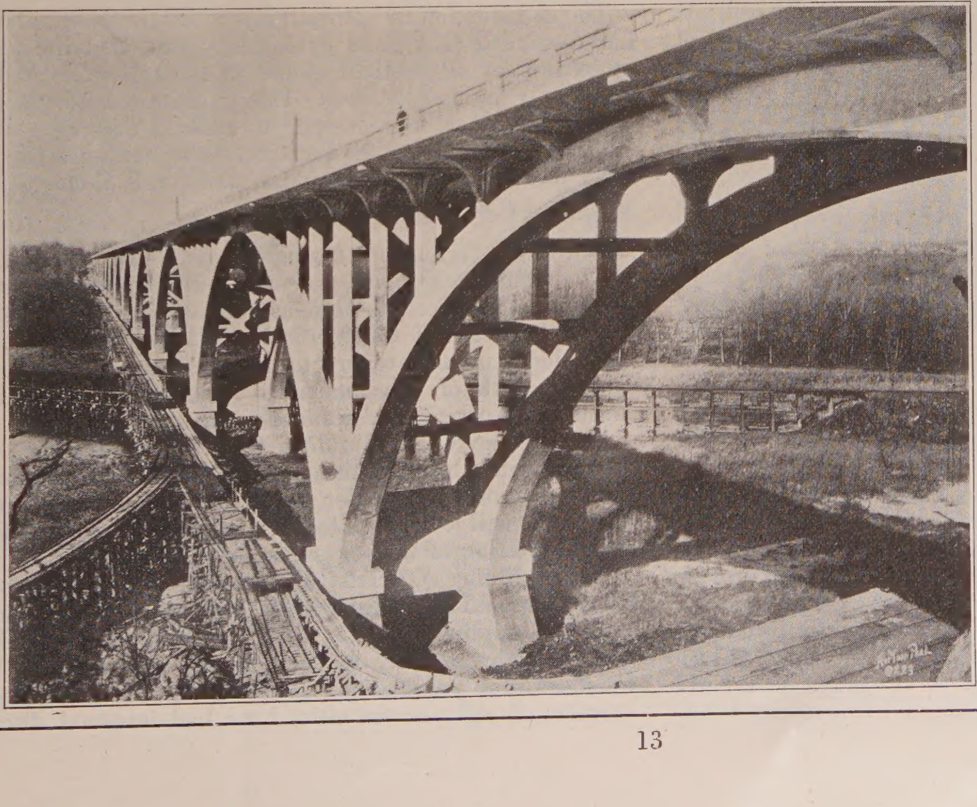
THE year just passed has seen notable progress in the specialized field of concrete construction as well as in the general structural field. In some directions the progress made is largely a continuation or extension of the accomplishments of previous years. In others there has been a development of new ideas or undertakings. Natural forces, too, have helped to make the year notable in structural history. The lessons learned from the behavior of structures in two major hurricanes will add much to our knowledge of the character and intensity of the force exerted by violent storms.

Bridges

Designers and builders of bridges have reason to feel gratified at the progress in bridge engineering. The Mendota-Fort Snelling bridge, across the Minnesota River, near Minneapolis, was completed during the year. This is a reinforced concrete multiple-arch bridge with 13 spans each 283 feet in the clear. While the individual spans are not the longest concrete arches built in this country, they are among the longest; and the total length of 4,119 feet places this bridge among the largest structures of its kind.

Another large concrete bridge under construction during the year is a three-span bridge across the tidal estuary of the River Elorn, at Brest, France, each arch having a clear span of more than 600 feet.

In the matter of bridge design and construction methods the outstanding event was the disclosure to American and Canadian engineers of details of methods used in France whereby arch bridges of reinforced concrete are built to much longer spans than in this country. Two papers were presented on this interesting subject by J. F. Brett, a consulting engineer of Montreal, the first in January before the Engineering Institute of Canada, at that organization's annual meeting in Toronto, and the second and more detailed paper in September before the Western Society of



The Mendota - Fort Snelling bridge across the Minnesota River near Minneapolis is one of the largest structures of its kind. It was completed and opened to traffic in 1926

Engineers in Chicago.

It has long been known that French engineers were designing and building reinforced concrete arch bridges of very long span. Little publicity had been given to their methods, however, and few bridge engineers in this country or Canada were familiar with them. The temporary hinge methods described in detail by Mr. Brett may be expected at an early date to become a part of common practice in this country, with the result that concrete arch spans will be built to much greater length. An article in the October (1926) issue of CONCRETE describes these methods.

Buildings

The United Brethren Building, a 21-story reinforced concrete office building completed in 1924 in Dayton, Ohio, still holds the height record for reinforced concrete buildings in this country. The average height of the taller concrete buildings has, however, been pushed upward. The year has seen the beginning of many such buildings to be built to heights of 17 or 18 stories. The Detroit Towers Apartments, a 19-story reinforced concrete building completed in 1926, has attracted much attention because of the published comparison of cost of its reinforced concrete structural frame and a similar frame of fireproof structural steel. The comparison credits the concrete frame with a saving of $50,000, the specific figures standing at $171,000 for the structural frame of steel and $121,000 for the frame of concrete.

The 19-story Detroit Towers apartment building in Detroit, Mich., is another notable example of reinforced concrete construction during 1926

Another notable reinforced concrete building that was nearly completed at the end of 1926 is the Hotel Palacio Salvo, in Montevideo, Republic of Uruguay. This building, 28 stories above the sidewalk and two stories below, is the tallest building in South America and the tallest reinforced concrete building in the world.

Dams

The outstanding dam project of the year is the Santeetlah dam for the Aluminum Company of America near Calderwood, Tenn., on which work is well under way. The volume of concrete involved amounts to about 500,000 cubic yards, equivalent in amount to the concrete in 200 miles of highway pavement.

Chimneys

The huge reinforced concrete chimney for the Consolidated Mining and Smelting Co., at Tadanac, British Columbia, towering to a height of 400 feet above its base, was completed early in 1926. It is among the tallest chimneys on the North American continent.

Field control methods were used in constructing the reinforced concrete frame of the St. Claire Realty Co. building in San Jose, Calif., completed during the past year

In the Florida and Cuban hurricanes, to be touched upon later, reinforced concrete chimneys displayed remarkable ability to resist storms of the first magnitude.

Stadiums

The construction of both large and small athletic plants has continued at a good pace. It is said that the total attendance at all football games in the fall of 1926 exceeded all previous records. This is quite significant, for it indicates that the interest in athletic events is still growing, and that further construction of stadiums can be fully justified from the economic standpoint alone.

Building Regulations

Uniform city building codes can no longer be said to be a dream; and in no previous year has the progress made in this direction been as far-reaching as in 1926. The Department of Commerce Building Code Committee has added another report to its previous publications, under the title of "Recommended Building Code Requirements for Working Stresses in Building Materials."

The Pacific Coast Building Officials' Conference has completed and printed the tentative draft of a proposed uniform building code for cities in Pacific Coast states. The code will come up for final adoption at the 1927 annual meeting of that organization.

The Building Officials' Conference of the State of Florida, organized in July, 1926, is likewise at work on a uniform building code for the cities of that state. The Florida code is likely to keep closely in line with the Pacific Coast publication. In Kansas the building inspectors of eight or ten cities have had informal discussions and expect to hold an organization meeting in the early part of 1927.

In all these undertakings there is involved the double advantage of uniformity in requirements and modernization of requirements, both tending to reduce or eliminate wasteful construction while at the same time attaining structural safety.

Tests of Concrete

Research work in the field of concrete is continuing in many directions. Tests of particular interest are the long-time tests on specimens of concrete in sea water, in progress for several years under the supervision of the United States Navy Department Bureau of Yards and Docks. The specimens stored in sea water are in Pearl Harbor, Hawaii, and at the Portsmouth Navy Yard. The tests are not completed, so that nothing has been given out for publication.

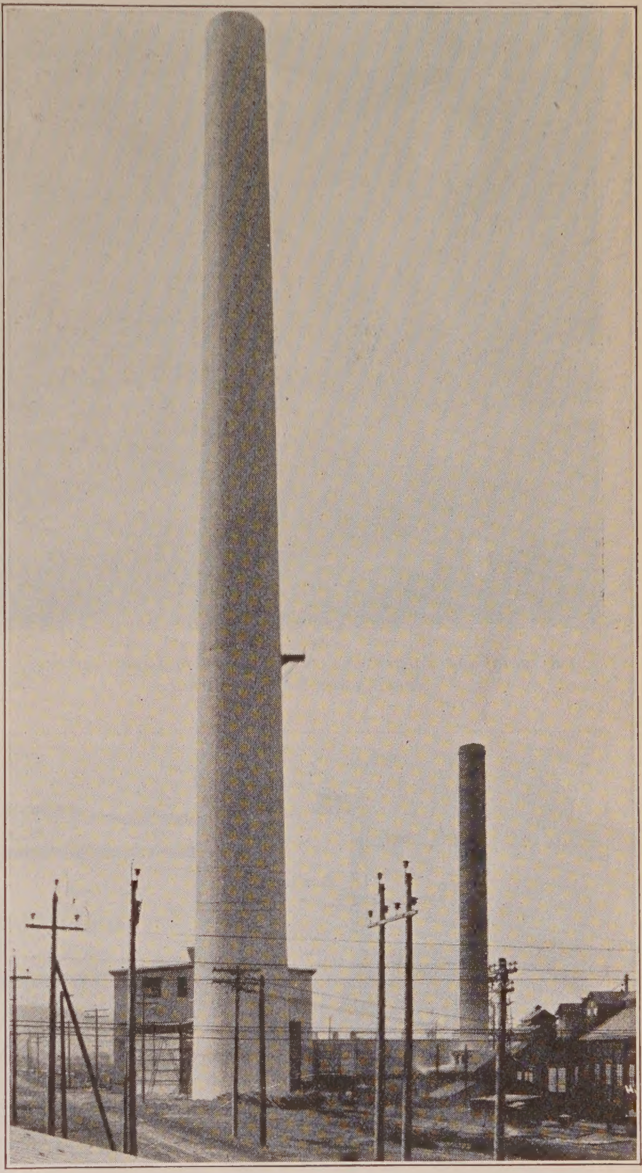
Quality of Concrete

Very decided advance has been made during 1926 in the practical application of field methods of controlling the quality of concrete. On scores of bridges and buildings control methods have been introduced, with thorough success. Railway engineering departments are rapidly introducing control methods in their construction work, and are in fact setting the pace in this respect.

Among the important concrete structures on which field control methods were employed during 1926 are the Portland Cement Association Building in Chicago, the city hall at Pasadena, Calif., the St. Claire Realty Building at San Jose, Calif., the double-deck Wacker Drive in Chicago, the McCormick Hotel in Chicago, the piers of the Santa Fe Railway bridge over the Mississippi River; the Mendota-Fort Snelling bridge across the Minnesota River; the approach viaduct of the Toronto Union Station, the piers of the Montreal South Shore bridge, all work on the new line of the Hocking Valley Railway in Southern Ohio, the overhead structures of the C. & O. Railway at Marmet, Ky., and the approaches and viaduct of the Indianapolis Union railway terminal.

During 1926 the Portland Cement Association moved into its new all-concrete building, in which the many architectural possibilities of concrete are illustrated

Another important factor in developing knowledge with respect to the control of the quality of concrete is the series of short courses conducted by the Portland Cement Association. The remarkable interest manifested in these short courses is perhaps the most encouraging thing about them. Attendance runs into the hundreds, thereby proving the adage, "Once a student always a student." The men who attend these courses are the men who are, or will be at some future time, in responsible charge of important construction work.

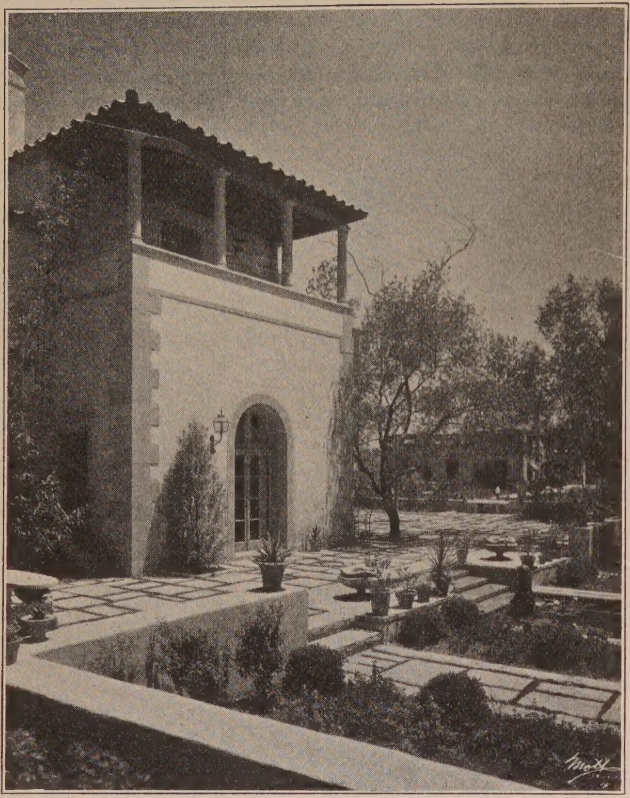


One of the tallest concrete chimneys on this continent was completed early in 1926 for the Consolidated Mining and Smelting Co. of Canada at Tadanac, B. C. Its height is 400 feet

Studying the Effects of Violent Storms

The year 1926 was unusual in the number of storms of great violence, the most destructive of which were the Florida hurricane of September 18 and the Cuban hurricane of October 20. In the wind velocity attained and in the destruction of life and property both these storms were the most violent ever experienced in the regions affected, and the two were of about equal intensity.

Extensive engineering studies were made in the wake of these storms, with the result that we have added much to our knowledge regarding types and methods of construction best fitted to withstand storm damage. A most reassuring thing about these engineering reports is the agreement among them that structures properly built with good materials withstood the storms.



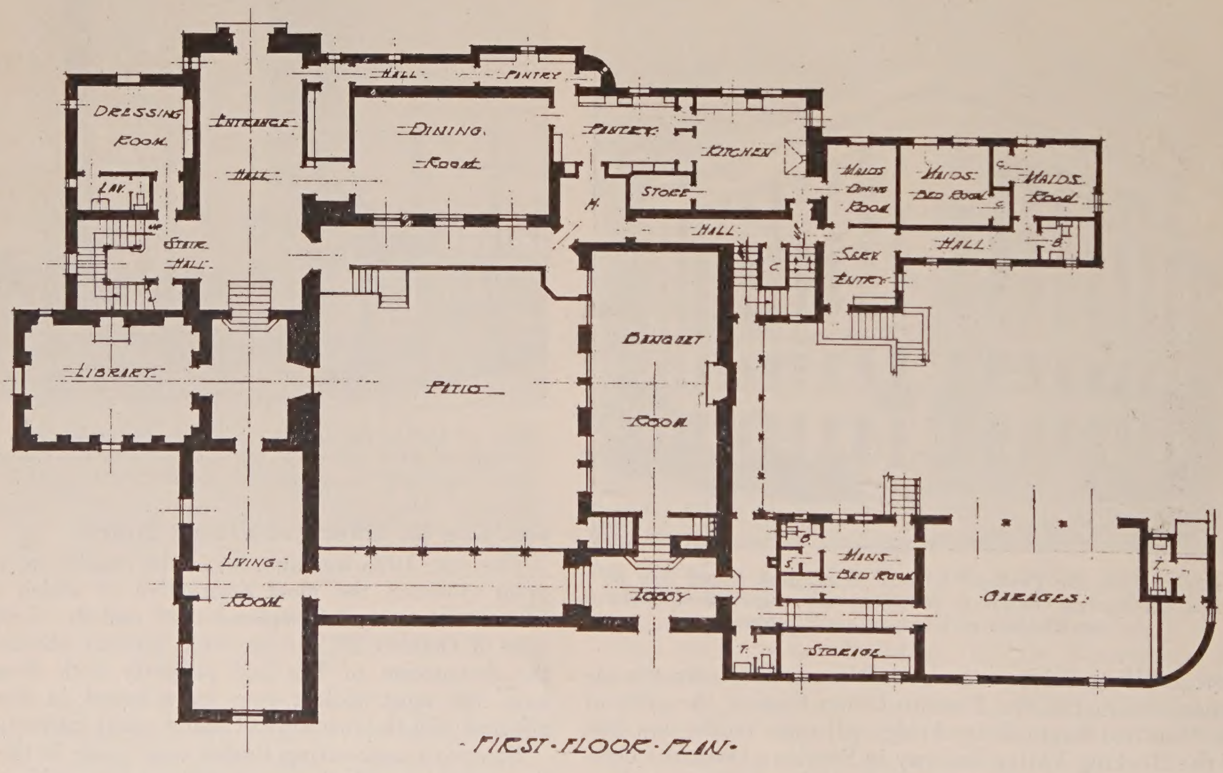
A bit of the garden and the concrete flagstone terraces, showing the library entrance

A Charming All-Concrete House ~

ONE of the most lovely as well as distinctive town residences in America is the recently completed home of Mr. I. Eisner, located amidst suburban surroundings at Sixth Street and Muirfield Road, Los Angeles.

Mr. Eisner's home is of particular interest to readers of CONCRETE because it is a charming example of the use of concrete for fine residence construction. The architecture is rather distinctive, and the nearest comparison would probably be to the old world Italian types, relieved here and there by the skillful interjection of modern American details where required to insure present standards of comfort and convenience.

The building has a ground plan approximately 110 feet by 160 feet with a patio about 60 feet by 40 feet and a partially enclosed courtyard of about the same size. Main portions of the building are two stories in height. Stonetile structural units were used throughout the building and its surroundings, each unit taking the place of three ordinary brick. The first story walls are reinforced in order to secure ample stability against possible earthquake shocks. Vertical reinforcing was run through the continuous vertical air spaces at intervals of six feet,



FIRST FLOOR PLAN
The building has a ground plan approximately 100 feet by 160 feet with a patio about 60 feet by 40 feet. The main portions of the building are two stories in height

The Home of Mr. I. Eisner
Sixth Street and Muirfield Road
Los Angeles, Calif.

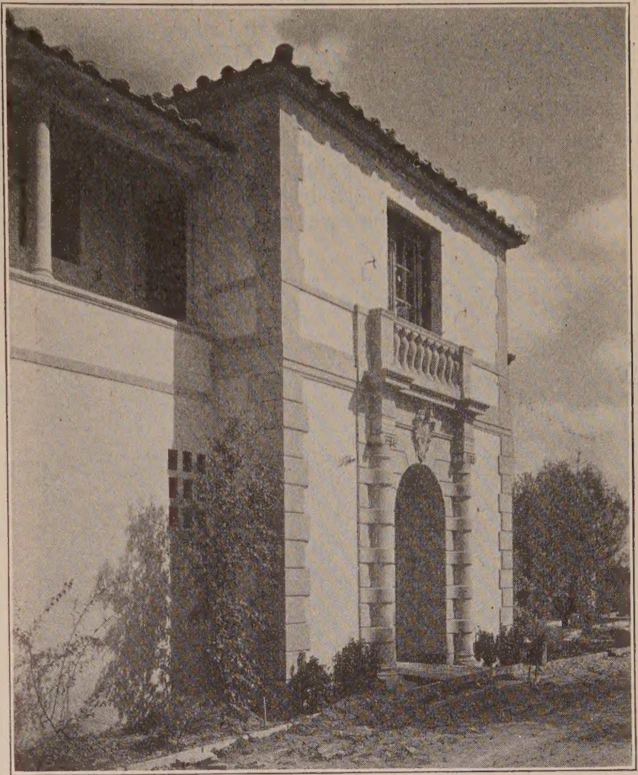
Gordon B. Kaufmann, Architect

center to center. One-half inch square bars were used for this purpose, being grouted into the spaces occupied.

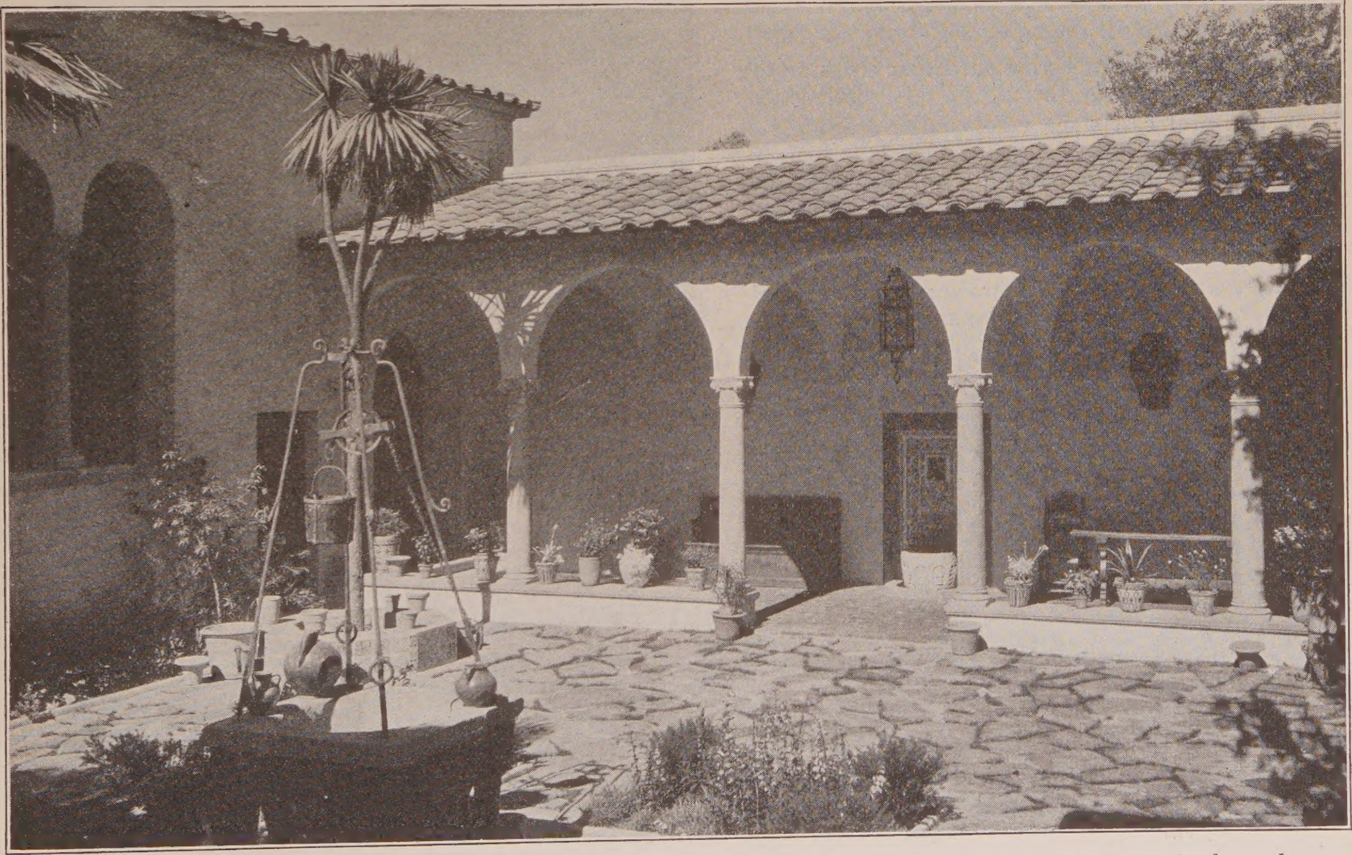
Cast-stone architectural trim was used on the exterior of the building, all remaining portions of the surface being covered with portland cement stucco of a smooth Spanish texture, admirably adapted to the general lines and setting of the house. The views showing the garden walls and terraces give an idea of the quantity of concrete used in these surroundings. Concrete cast stone was used for the terrace flagging between the sections of which a fine mat of green grass provides pleasing contrast. The ornamentation on the exterior, notably that of the entranceways, is of classic origin and the details have been worked out with an unusual amount of interest.

In the patio there is a cut-stone well-head and a cut-stone doorway both very old, imported from Italy. Several placques of similar material have been artistically studded into the patio walls, these decorations combining with the lines of the building and the semi-formal arrangement to give a very restful antique effect.

Within the Eisner residence one is attracted by the main interior stairway of concrete of a type not often found

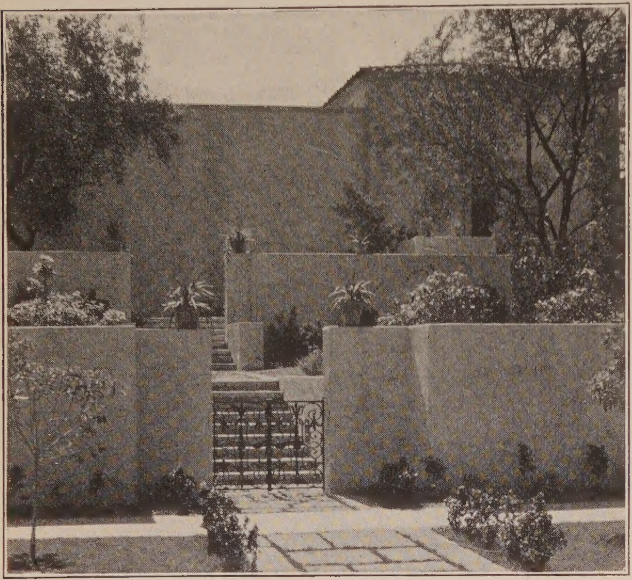


The main entrance, of precast concrete stone



The cloistered patio with ancient well head, concrete flagging in which the effect of age has been carried out, circular arches, Italian tile and Spanish tile roof. An altogether pleasing effect has been secured, using concrete almost exclusively in buildings of this kind. The steps, balusters and rails are of precast concrete without decoration except for ornamental baluster capitals. The baluster spindels are about 3½ inches in diameter and the rail 10 inches wide, which, with the broad tread of the steps and the spacious stair hall, produces an imposing effect.

The architect, Mr. Gordon B. Kaufman of Los Angeles, states that concrete tile and cement stucco used in combination are well adapted to carrying out the architect's conception. Mr. Kaufman's work has been subject to much favorable comment, and the owner is particularly pleased with the concrete tile walls, laying particular stress on the good insulation secured by the use of this construction.



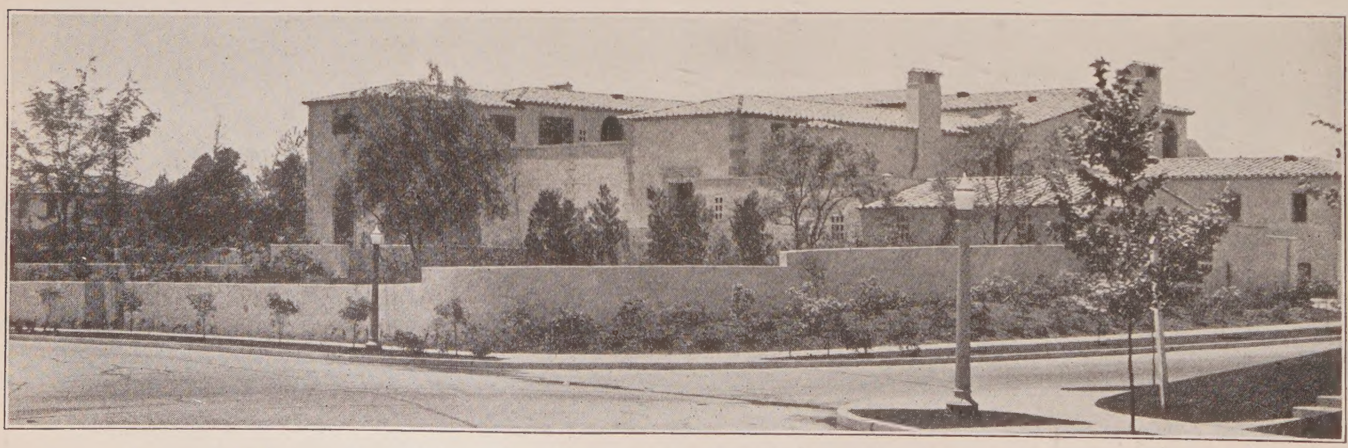
An interesting bit of terrace which displays the possibilities of cement stucco

The architectural cast stone used on the exterior and interior and about the courts was modeled and manufactured by the Watkins Art Stone Company, while the beautiful stucco and decorative plaster work were done by Lance and Sheeley. The decorating on the plaster was by Smeraldi.

John Mayer was the general contractor while the hardwood interior work, including wall panelings, was done by Marshall Laird, the numerous chandeliers, candelabra, and other fixtures of wrought iron and cut glass being made by B. B. Bell.

The landscaping around Mr. Eisner's residence, which adds rare charm to almost every possible view, is the work of Paul G. Thiene, landscape architect of Los Angeles.

The ornamentation of the doorway is of cast architectural stone



A general view of the house. Stone tile structural units were used. The first story walls are reinforced to secure stability against possible earthquake shocks

When May Concrete Pavements Be Opened to Traffic?

A Discussion of Some of the Principles Involved—Arbitrary Length of Curing Period Imposes Unnecessary Restrictions — Cross Bending Strength Tests Indicate Time Required for Gaining Adequate Strength—The Experiences of Some States in Shortening Curing Periods —Methods of Making Tests and Apparatus Required

By H. F. CLEMMER
Solvay Sales Corporation

WITH the enormous increase in traffic, the economies in transportation effected by road improvements have become very important to the public.

A few years ago, when there was but a small mileage of improved roads and a comparatively small volume of traffic, as compared to the present conditions, the importance of opening a concrete road to traffic as soon as possible, was not realized. However, with the advent of motor traffic, and data available as to the cost of using detours as compared to the finished pavement, not considering the inconvenience caused the public, the urgency of permitting the traffic to use the road as soon as the concrete has gained adequate strength has been demonstrated. Also the development of cements, special mixes, and accelerators which produce early strength concretes, has made possible early use of pavements which has heretofore been impracticable.

IN the past, engineers have specified an arbitrary length of time for the curing of concrete pavements before opening to traffic, not taking into account the fact that all concrete does not gain strength at the same rate. The different materials and methods used in manufacturing the concrete particularly affect the early strength of the concrete. It was seldom that early strength tests of any kind were made, and then only in compression which does not necessarily indicate the resistance to cross bending, the manner in which concrete pavements fail.

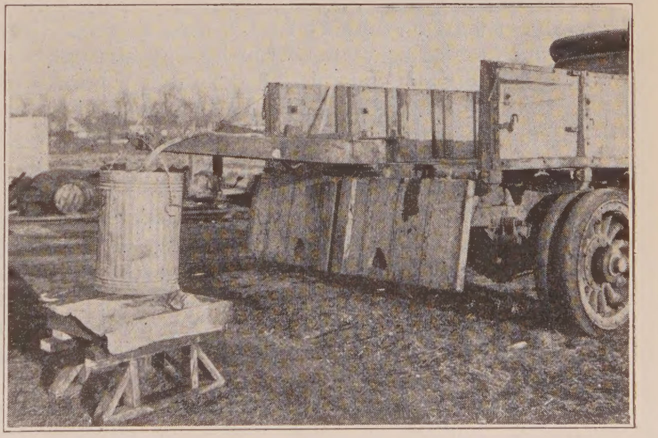
Even though the length of time set for curing in the past was generally twice that required at the present time, still, without question, many of the pavements were opened to traffic before the concrete had gained sufficient strength, when conditions for curing were not of the best, such as during the fall months when the temperature is low.

Loads at Free Corners

It is certainly important that the cross bending strength of the concrete be known before it is subjected to loads which might cause it to fail rather than to set an arbitrary length of time for the curing, which in some cases is much longer than is necessary for the proper curing of the concrete, and in other cases, curing conditions being unfavorable, the concrete has not gained the strength necessary to support the loads imposed upon it.

The theory upon which a large number of highway departments are basing their design of concrete pavements, is that of the maximum wheel load placed at a free corner; no subgrade support is taken into account, so that the corner of a slab is considered as a cantilever. Substituting the moment for a cantilever in the simple formula $S = \frac{Mc}{I}$, we have $S = \frac{WLc}{I}$, the actual stress which would be caused by this load with a given thickness of slab and under the conditions imposed. This formula was applied to pavement design during the Bates Road Tests by Mr. Older and fully discussed by him in a paper presented to the A. S. C. E. in 1924.

When it is realized that a definite maximum load is considered in determining the thickness of concrete necessary for a pavement, the importance of restricting all loads to this given limit may be understood. If, at any time permission were granted to increase this maximum load, a real danger would be incurred as to the life of the pavements which have been built with the limit used as a consideration in their design.



One easily constructed apparatus used for making cross bending strength tests

It is true the factors, such as fatigue, etc., must be taken into account in determining a safe working unit stress.

When there is this possibility of fatigue occurring, that is, when the pavement will probably be subjected permanently to a large amount of heavy traffic, it is found that a factor of 2 should be used, that is, a working unit stress of about one-half the ultimate strength of the concrete should be used in determining the required thickness of concrete for the pavement which is to support definite loads.

When the demand for early opening of a pavement is to allow the contractor to truck his materials over the slab, as is often of great help economically and in speeding up construction, especially when half widths of pavement are being built, it is possible to require the trucks to keep in the center of the slab, which can easily be done by placing obstructions, such as timbers or rock along the edges of the pavement. This will keep the loads from coming directly on a free corner and there will be a sufficient factor of safety to offset the possible fatigue which might occur under such conditions.

Strength Requirements

There has been considerable discussion as to what the matured strength of concrete should be for pavements but that discussion has dealt with the pavements under the most adverse conditions, that is:

> When the slab may not receive any definite subgrade support, as is probably the case when the frost is leaving the ground in sections having a subgrade which holds a large per cent of moisture.
>
> When the traffic consists of a large number of heavy vehicles which might cause fatigue.
>
> When the loads are applied directly on free corners of the slab formed by the occurrence of transverse cracks due to temperature changes.

But there has been very little discussion as to what the strength of the concrete should be under the conditions at the time of opening a new pavement. There are many conditions which pertain during the early curing of a concrete pavement which are factors of safety so that when the strength of the concrete in the road has reached the unit working stress used in the formula it is safe to subject it to the loads considered, that is, it is not necessary to use a factor as referred to above to take care of possible fatigue, etc.

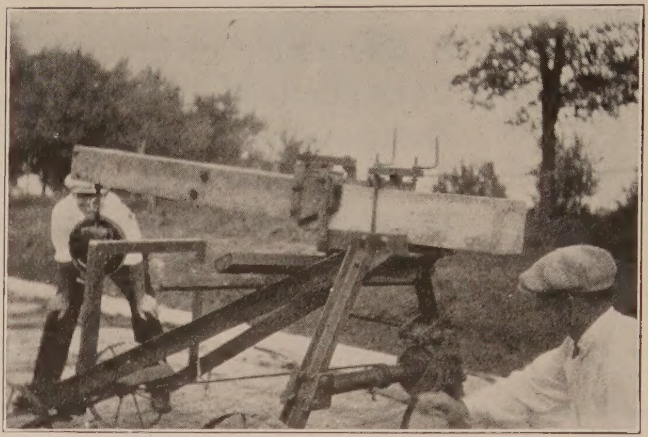
> The slab would, without question, receive considerable subgrade support for at least a period long enough for the concrete to gain its full strength.
>
> It is probable traffic would not reach a point such as to cause fatigue. Light loads such as pleasure vehicles, which do not stress the concrete beyond 50 per cent of the modulus of rupture will not be a contributing cause for fatigue.
>
> Obstructions may be placed along the edge of the slab so that the loads would not be applied directly on a free corner, at the edge of the pavement. When dowel bars are used across construction joints, free corners would be eliminated for the dowels should function perfectly, especially when the pavement is new.

All of these factors serve as measures of safety against non-uniform concrete or other conditions affecting the uniform strength of the concrete.

Cross Bending Strength Tests

Therefore, if the cross bending strength of concrete specimens which are made of the same concrete as the pavement slab and cured under exactly the same conditions as the concrete in the pavement, is determined at various ages, it is entirely safe to open the road to traffic as soon as the concrete has attained a strength sufficient to support the maximum load which is to be permitted on the pavement, as determined by substituting in the formula referred to before. Especially should this matter receive attention when the inconvenience and the cost to the public is taken into account.

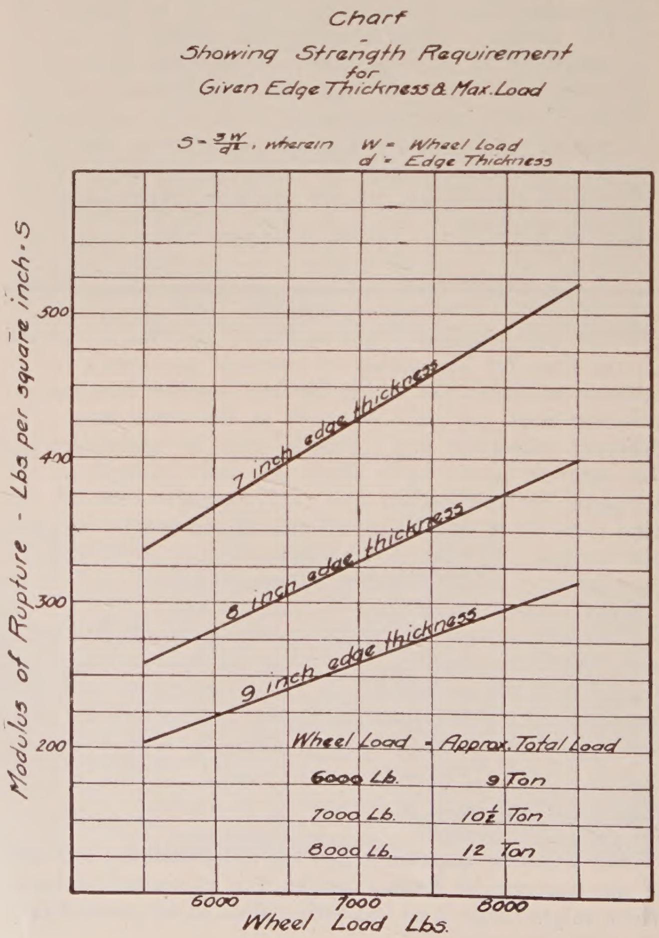
There is no more reason to prohibit traffic from using this pavement under the above conditions than to refuse to permit the maximum load on the pavement which was considered in designing for the quality and thickness of the slab.



Another type of field test apparatus in which the strength is recorded on a dial

A chart is given below which shows the strength of concrete as modulus of rupture in pounds per square inch which must be obtained before traffic of the given maximum loads should be permitted to use the pavement.

The concrete should be so designed that the matured strength will be twice that at which the pavement may be opened in order to take care of fatigue and impact, which



may occur under later conditions, and of free corners which may develop later due to transverse cracks and at a time when the concrete is contracted and the slab allowed to move.

Method of Making Tests

A simple cantilever method of test has come into quite general use in determining the cross bending strength of concrete.

The machine consists of an extension arm which may be fastened to the free end of a specimen beam which is held in cantilever. The load is then applied by pouring some free running material at a uniform rate into a container which is fastened to the end of the cantilever arm. This simple method of test has made possible field testing which requires little labor and expense and gives results which are directly indicative of the true strength of the pavement concrete.*

For this purpose test beams are made in forms from the same mix as used in the pavement. These specimens are allowed to cure under the same conditions as the pavement concrete and are broken at regular intervals in the field with this simple testing device.

The specimens may be held in cantilever by clamping to the rear end of a truck or other improvised platform. The loading medium can be water which may be measured and the load thus determined so that scales will not be required on the job.

A very satisfactory framework for holding the specimens and by means of which the load may be applied and measured with a dynamometer has been devised by the testing department of the Minnesota Highway Commission. This machine has proven very convenient and very satisfactory for use in the field. Care should be used to be sure the dynamometer is properly calibrated, and that the load is uniformly applied so as not to cause the effect of impact or fatigue while testing.

Advantages

The advantages of this test as compared to the former method of determining the compression strength are:

The saving in cost and time, as the apparatus necessary to make the test will cost but a few dollars and may be assembled in the field.

That the method will give more uniform results due to the manner of testing.

That the specimens may be tested in the field and therefore the concrete is tested under exactly the same conditions as those existing in the road slab.

The cross bending strength is determined rather than the compression strength which is not necessarily indicative of the cross bending strength of the concrete, and which is the manner in which concrete pavements fail.

The practice of making these tests in the field and opening the pavements to the public as soon as the concrete has increased in strength to that used in the design formula is being adopted by many state highway departments.

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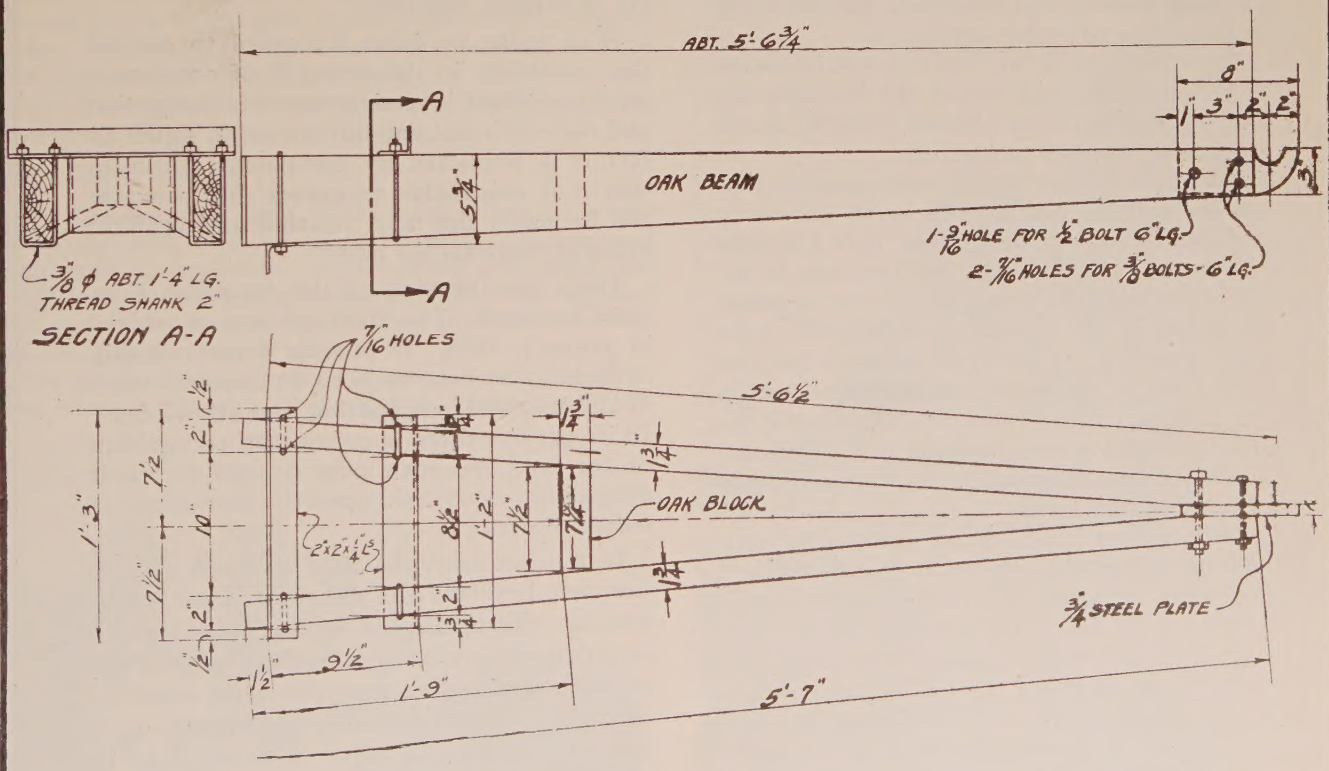
*"Transverse Testing of Concrete," American Concrete Institute, February, 1926.



TRANSVERSE TEST BEAM FOR CONCRETE BARS.
THE SOLVAY PROCESS CO. SYRACUSE, N.Y.
SCALE 1½" = 1 FOOT DATE: 8/19/1926
ENTRY Nº 62713

On most public highways at least 90 per cent of the traffic consists of lightweight traffic, such as pleasure vehicles, etc. This class of traffic should not be held from the pavement until sufficient strength is reached in the concrete to carry the heavy truck loads. It would certainly seem advisable to expend any amount that may be required to properly police the road so as to make it satisfactory to allow the light traffic to use the pavement for which the strength is fully adequate and preclude the heavy traffic which might cause failure until the concrete has gained greater strength. A determination of the saving which will result to the public in being allowed to use the concrete surface rather than being required to use the provided detour for even a short time will prove the importance of this matter.

The State Highway Department of Pennsylvania has been carrying on this manner of testing to a considerable extent and recently opened a pavement to traffic in 89 hours.

The maximum load which was to make up the traffic was taken into account as was the edge thickness of the concrete slab and the road was opened to traffic when the tests showed the concrete had gained sufficient strength as determined by the design formula. Proper care in making the concrete and ideal curing conditions were undoubtedly responsible for the early strength of the concrete but unless the cross bending tests had been made and the strength required to carry the traffic determined from the design formula it would have been unwise to risk opening this pavement to traffic in such a short time.

This indicates the rapid advancement that is being made in highway construction practice.

The American Concrete Institute

FEBRUARY 22, 23, 24, 1927, are important dates in the concrete industry. For it is on these days that the American Concrete Institute will meet at the Palmer House in Chicago.

An excellent program has been prepared. There is much of interest for every one engaged in any of the many branches of the concrete industry. At this meeting you will find yourself cordially welcomed and you will go away feeling that you could not have put in your time to better advantage.

The fine spirit of the Institute and its vision of the service it can render the industry are well expressed in the address made by A. E. Lindau at the 1926 convention:

"With all due respect to other agencies that are at work in our field to solve our many problems, it seems to me that it is a special privilege and function of the Institute to assume and maintain leadership in the technical activities of the industry. While we have every reason to be proud of the work that has been done, of the service we have rendered in the past, the future value or usefulness of the Institute is intimately related to the seriousness with which we accept the responsibilities of our position. . . .

"We are on the verge of some important and fundamental changes in our method of providing concrete. We have passed through a cycle of the early simple process of combining a unit quantity of cement with fixed proportions of fine and coarse aggregate to a more complex method of designing the mix on the basis of a screen analysis of the aggregate combined with a suitable water-cement ratio, and are now about to emerge to an even simpler process than that with which we began, by merely specifying the quantity of water per unit volume of cement, allowing the proportions of the aggregate within reasonable limits to be determined by workability. I say we are about to emerge, for we have not yet arrived at a point where this broad and simple conception can be pronounced as thoroughly practical and satisfactory. Should the extensive investigations which are under way establish the soundness of the new practice, we shall revolutionize present methods and enter a new era in the art of making concrete.

"For years we have struggled to control the variability in the strength of concrete—we have added investigation to investigation and the end is not yet, but almost in sight. In fact it is predicted by competent authority that it is reasonable to expect that concrete can be made the most reliable and uniform building material we have."

These are the aims of the American Concrete Institute. The Institute was organized in January, 1905, "to provide a comradeship in finding the best ways to do concrete work of all kinds and in spreading that knowledge." In its growth there is convincing recognition of the fact that men now depend for their progress in every field upon the knowledge of fellow workers.

In a broad way, the aims of the American Concrete Institute and the aims of our magazine are very much the same. In our pages we strive to present the helpful experiences of engineers and contractors everywhere so that their knowledge may be passed on to you to the end that better concrete may be more economically made.

We welcome this opportunity to tell our readers again of the American Concrete Institute, knowing that all of them would derive much benefit from it.

High Grade Homes in a Subdivision

This Real Estate Development Was Started Off on the Right Foot by Means of the Construction of Ten Concrete Masonry Homes of the Highest Order, Each a Good Example of the Best Architectural Treatment

ONE of the most striking examples of the high standing which is now enjoyed by the concrete masonry building unit is afforded by the "Sunny Ridge" real estate development at Harrison, N. Y., where H. & S. Sonn, Inc., of New York are building a $350,000 group of concrete masonry homes from plans by Julius Gregory, architect.

The Sunny Ridge development is situated on a high tract of land, within sight of Long Island Sound, in the Harrison-Rye neighborhood, the property being within a short distance of the Harrison station of the New York, New Haven and Hartford R. R. Harrison Avenue, which forms one of the boundaries of the property, is the means of access to an extensive area of medium and large sized country estates and fine suburban homes, and clubs. In order to fix the character of the development at the outset it was decided to erect ten suburban homes of the finest type, demonstrating as well the possibilities inherent in the property for artistic homes.

Julius Gregory was retained to draw the plans. Some of the most charming suburban homes in the vicinity of New York have come from Mr. Gregory's office, and followers of his work know his skill in handling brick, timber and stucco in the style of the larger English country homes. Mr. Gregory and the developers as well had to be sold very completely on the quality of cinder concrete block before they would trust to it their respective names, needless to state.

High Grade Homes

The houses are all large. They contain from three bedrooms up, with sleeping porches, maids' quarters and baths, built-in garages, etc., and are priced at from $35,000 to $45,000—in round figures—not the type of development where it can be charged that concrete masonry units were used because they were "cheap."

The accompanying illustrations speak louder, however, than words. Figure 1 shows the first house completed.

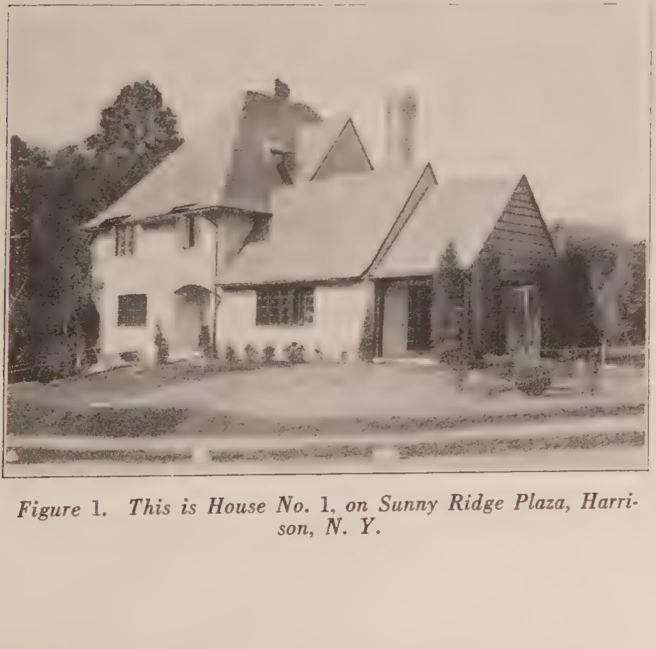


Figure 1. This is House No. 1, on Sunny Ridge Plaza, Harrison, N. Y.

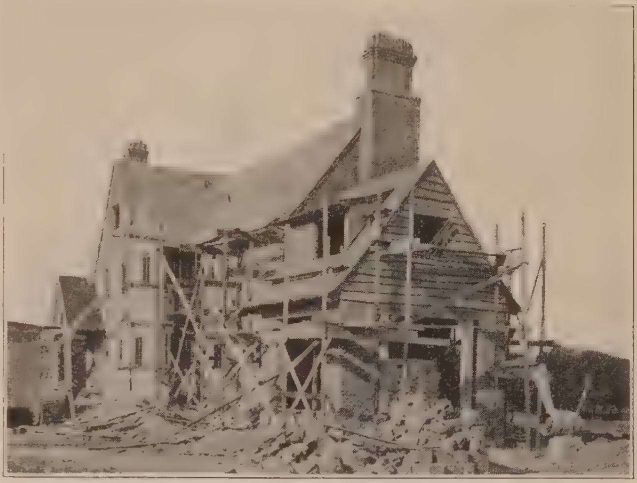


Figure 2. A brick veneer house, House No. 7, on Bates St., Sunny Ridge.

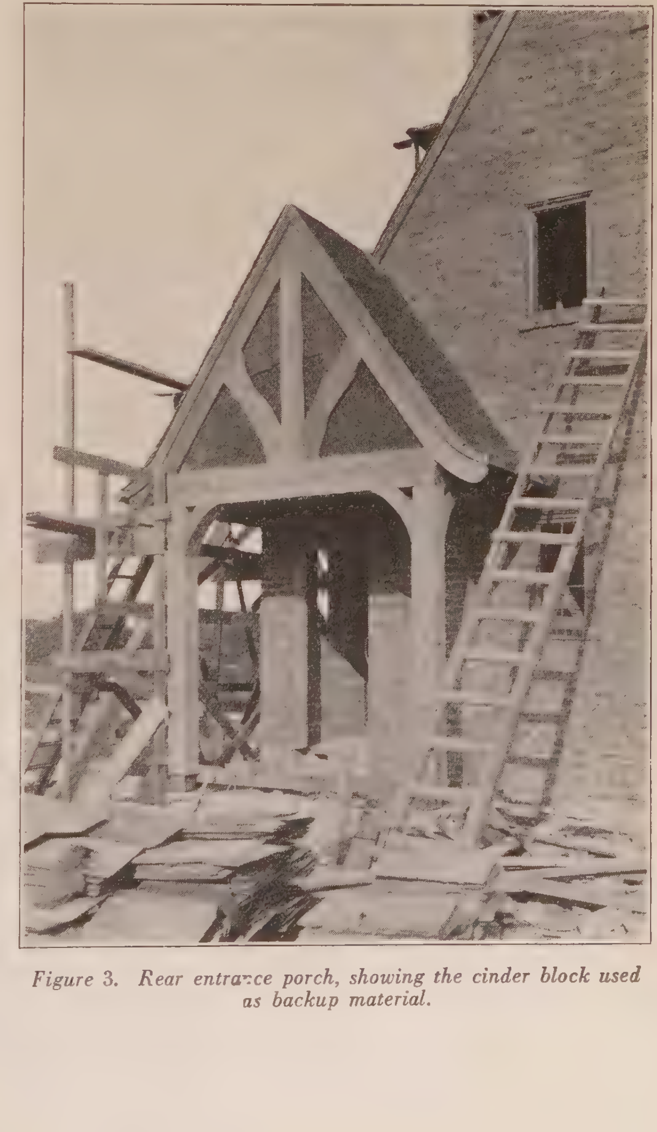


Figure 3. Rear entrance porch, showing the cinder block used as backup material.

The living room occupies the entire wing in the foreground, and the open porch, which is slate paved, is nearly half the size of the living room. One of the outstanding features of the house, architecturally, is the deep entrance porch, recessed into the house, extending the hospitality of the owner, in the shape of shelter within the walls from storms, to the waiting guest. An Artstone stucco finish in English cottage texture was used, in a cream color. Trim is stained brown.

House No. 7, located on Bates Street, with a view across several intervening miles of terrain to Long Island Sound, is a brick veneer job, with cinder block backup, as shown in Figures 2 and 3. While Figure 2 shows the rear of the house, owing to the position of the sun when the photo was taken, it can be seen that the care in architectural design has in no way been slighted. This is one of the largest houses in the group.

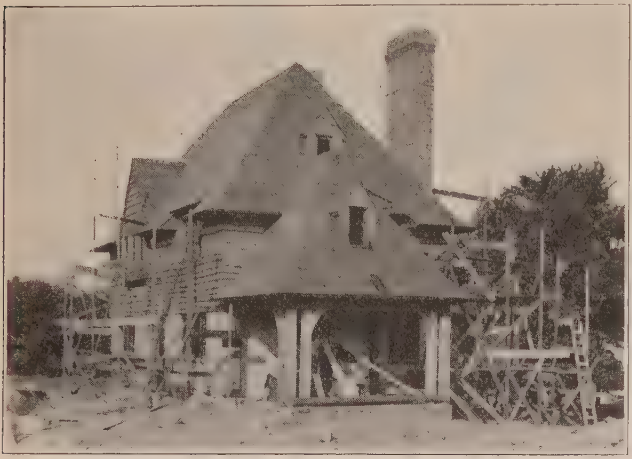


Figure 4. House No. 3, on Highfield Road, shows an interesting use of timber and stucco.

Odd Uses of Materials

Figure 4 depicts a most interesting home—House No. 3, on Highfield Road, practically across the street from the house last mentioned above. In this, the architect has used a combination of timber and stucco, the boards in the second story being cut the full width of the log, the edges of the boards being the outsides of the logs, and showing graphically the irregularity of the logs from which they were cut, just as was done centuries ago in the homes from which this twentieth century reproduction was modelled.

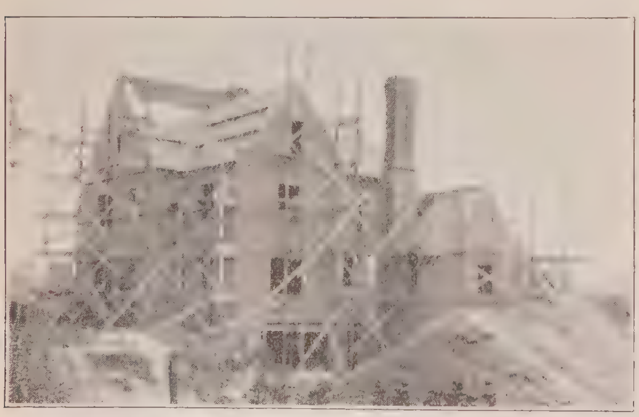


Figure 5. House No. 8 on South Road, where fieldstone, stucco and timber will be combined to afford the desired architectural treatment.

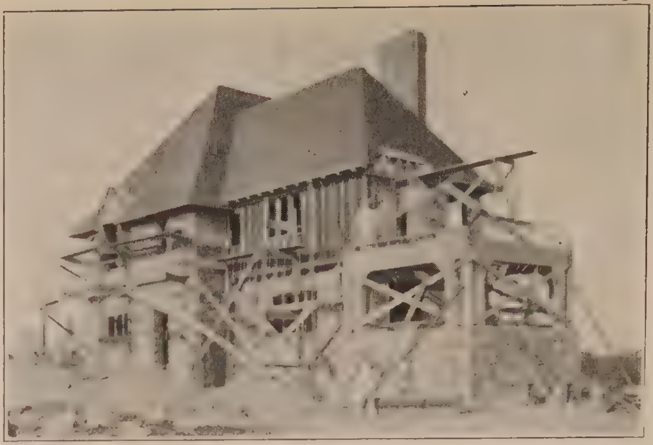


Figure 6. House No. 6, on Crawford St., again reveals an interesting use of fieldstone, stucco, and timbering.

Figures 5 and 6 show houses Nos. 8 and 6, located on South Road and Crawford Street, respectively. In both of these houses the architect has made liberal use of fieldstone in the lower stories, in connection with stucco and timber work.

Builders who are interested in the field of high-class construction will do well to note these houses, and then, looking up the nearest manufacturer of concrete building units, "go and do likewise."

Interesting Exhibit Leads to Orders at Fair

Tom Stony, the smiling fellow in shirt sleeves, sent in this photograph to show how his firm, the Concrete Pipe Company of Centralia, Washington, put over a successful exhibit at the Southwest Washington Fair near his town. He writes that the exhibit went over with a bang and attracted more attention than any other exhibit at the fair, and that orders for septic tanks and well curbing paid the cost many times over. Concrete pipe, he reports, is coming to the front in his part of the country. His firm has put in 20 miles of pipe for the city of Centralia alone in the last three years. The pipe were put in under the supervision of the city engineer, who says that he is now sold more than ever before on the use of concrete pipe for municipal work. Mr. Stony is manager of the plant, which uses the trade name "Graystone" for its products.

EDITORIALS

Our Faults

THERE is an old proverb to the effect that our real friends are those who point out our faults and shortcomings.

Considered from that standpoint, Professor George F. Swain of Harvard University is one of the best friends that the concrete industry has ever had. For, in two addresses, one before the American Institute of Steel Construction and later before the Boston Society of Civil Engineers, Professor Swain has gone to considerable trouble to tell us just what is wrong with concrete as a construction material.

He said, among other things, that: "(1) Concrete is not a finished product. It is made on the job. There are many uncertain elements, neglect of any one of which may result in poor concrete. The material is not finished until it is in the structure and then it cannot be rejected or recalled. (2) Concrete changes after it is placed in the structure. It changes in volume with variations in moisture content and the strength changes with temperature variations. Unless waterproofed, concrete is more or less porous and will swell and shrink with varying moisture in the atmosphere. (3) Computations of reinforced concrete structures are uncertain. Comparatively little is known about concrete design. Strength for strength, concrete weighs about seven times as much as steel. (4) There are always destructive agencies that may destroy it. The cement may be dissolved out. Concrete corrodes, as steel does, but in a more harmful way. (5) If unfair discriminations were removed and if more care were exercised to get skilled labor, to select suitable materials, and to have expert supervision, there is no doubt that reinforced concrete would not work out to be more economical than steel, in many cases in which it does now work out to be more economical."

These are serious indictments. And, to some extent, they are true. But it is to be regretted that Professor Swain did not also mention some of the advantages of concrete as well as all of its possible faults. In spite of the defects pointed out, the advantages of concrete as a construction material are well known and generally conceded.

It is good for an industry to have some one to stand up and tell it frankly and squarely what is wrong with it. We are too prone to sit back complacently, secure in the acknowledged merits of our materials. Concrete *does* have some disadvantages and it is well for us to recognize them. Having recognized them and admitted them, we can bend our efforts to overcome them.

Professor Swain has brought out several points that deserve the serious attention of the concrete industry. There are many opinions on the question of waterproofing concrete. Perhaps its more general use would do away with one of Professor Swain's criticisms. The subject of surface corrosion is one that can well deserve the industry's serious attention. We cannot merely ignore it and so consider the matter disposed of. Much progress can still be made in the theory of concrete design. With the newer methods of quality control of concrete in the field, more accurate design computations can be made. As quality control becomes more general, mass in concrete structures can be reduced.

Nothing makes for insecurity as much as a fixed feeling of security. Concrete has made wonderful strides in the last decade but more wonderful things are in store for it. To attain these, we must face conditions as they are, recognize our shortcomings and set about to overcome them.

In his concluding remarks at the meeting of the Boston Society of Civil Engineers, Professor Swain expressed the belief that his paper will make people think. If it does that in a constructive way for the concrete industry, Professor Swain's paper was a truly friendly gesture.

PROGRESS in the art of making better concrete is the composite result of many influences. The engineer in the field and in the laboratory is primarily responsible for the development of the principles of making quality concrete. But it is through the cooperation of the contractor and the equipment manufacturer that the application of these principles to field conditions is made practical.

The equipment manufacturer's place in the progress of the industry is seldom given the recognition that is his due. Yet it is largely because of his efforts that newer methods of quality control are economically possible out on the job.

The provision of accurate aggregate measuring devices, either by volume or by weight; the assurance of automatic, unfailing accuracy in the regulation of the quantity of water used and other refinements in concrete-making equipment are some of the definite contributions of the equipment manufacturer to the cause of better concrete. Without these developments in equipment design it would be a difficult matter to persuade contractors to adopt the newer methods.

Much has already been accomplished by the equipment manufacturer. His opportunities in the future are even greater. By selling equipment designed to improve the quality of concrete he is helping to educate the concrete user in the better methods of quality control.

Interesting Forms on Chicago Job

Unique Drop-Head Panel System and Other Details Help Contractor Hold Down the Costs on Job That Was Bid Low—Water Ratio and Fineness Modulus Control on Wheelbarrow Mixing Plant with Two Mixes on Each Floor Slab—A Simple Indicator in the Water Barrel—Other Pointers That Help Shave Costs with Good Workmanship

WHEN the responsible contractor finds himself with a job on his hands that was taken at too low a figure he casts about for ways and means of lowering costs by utilizing more efficient methods and by increasing labor productivity. In this case, an important construction firm faced that situation and solved it by a better form system, by a lower investment in equipment, by getting the architect to approve a change in detail that resulted in lower cost, by scientific control of the mix which gave a lower cement factor without sacrificing strength, by getting the men to take a greater interest in their work, and by making extra efforts to reduce the cost of accidents.—The Editors.

THE Emil J. Paidar Building, in Chicago, is advancing toward completion at a profit to the contractor in spite of the fact that costs threatened to be materially higher than the amount that was named in the contract. The contractor had no intentions of losing a profit in this case, even though it would be profitable to keep his men together during the cold weather. His decision was that everything possible had to be done to decrease the cost of the work without decreasing the quality of the work. That called for an increase in job efficiency in every way possible.

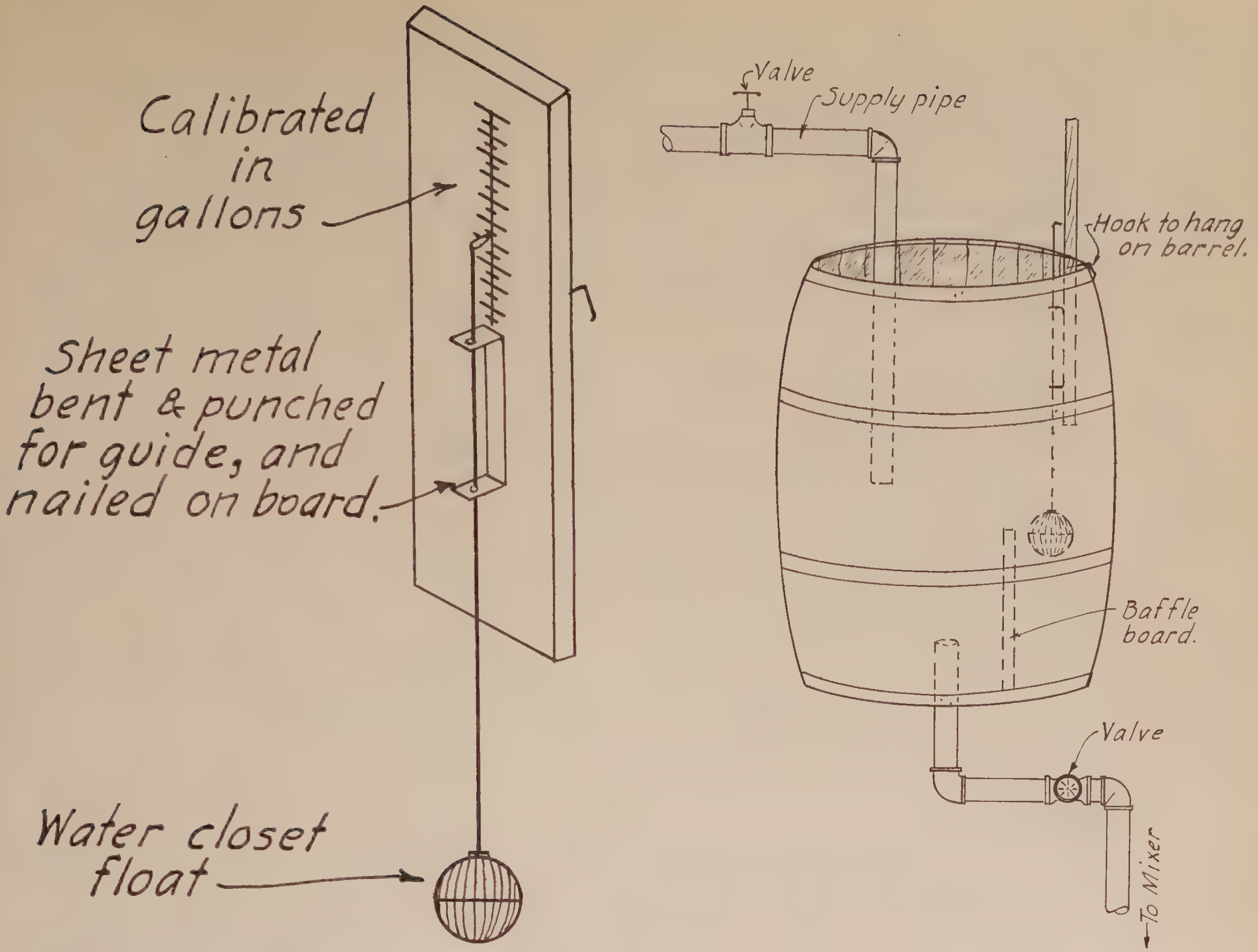
The analysis of job costs made by the firm pointed out that profit can be lost on the erection and stripping of forms, on the productivity of the workmen, on the cost of the concrete mix, on the cost of placing the concrete, and on the lost time accidents that ordinarily occur on construction, as well as on the flow of materials to the job. The concern has always been interested in these points, and their key men are especially selected for their efficiency in working out just such problems. By this means they are able to turn possible losses into actual profits when some other firms would simply have to absorb the loss or else reduce the quality of the work—which is unthinkable to the responsible concretor. The methods by which this particular problem was solved are of immediate interest to every other contractor.

The labor angles of the problem can be passed over briefly. It was found possible on this job to offer an incentive to the men, through the foremen, so that they were interested in getting things done at the earliest possible moment. Particular care was given to training each man, where necessary, in order that lost motion and excessive carrying of materials would be avoided. Then, too, the safety campaign being pushed by the organization was given the maximum attention on the job, and things were made as safe as possible for everybody. Rewards were posted that lead to safety competition between the various groups. The men were put into a cheerful frame of mind by the knowledge that everything possible was being done to keep them from injury, and everybody made it his business to keep himself and the other fellows out of trouble. The psychology of such work proved of direct value on that particular job, since a happy man is a better worker than the man who has to spend all his time trying to take care of his own neck.

The start of the job on August 21, with footings going in and concrete plant ready for service. Mixer in pit covered here with canvas, materials on the street

Form Details

Perhaps one of the greatest sources of economy and efficiency on the job came from the form ideas that were developed by the carpenter foreman and the superintendent. The column forms and drop heads were not set up in the usual way with the aid of benches, but were handled in a much more expedient manner. The first step was the erection of the outside column forms, exactly plumb and to line. Then lines were stretched between these column forms and the interior column forms were easily set to line and plumb on these line intersections. Four shores, of 4x4s, were then set up around each column, and 4x6s then nailed on top of them, as shown in the drawing. These come just to the edge of the drop-heads that go in later. Next the carpenter nailed the 2x10s from shore to shore on two sides. Across these he placed another 2x10 on the other two sides. During this time the other men were laying the 2-inch floor forms on the shores and these were



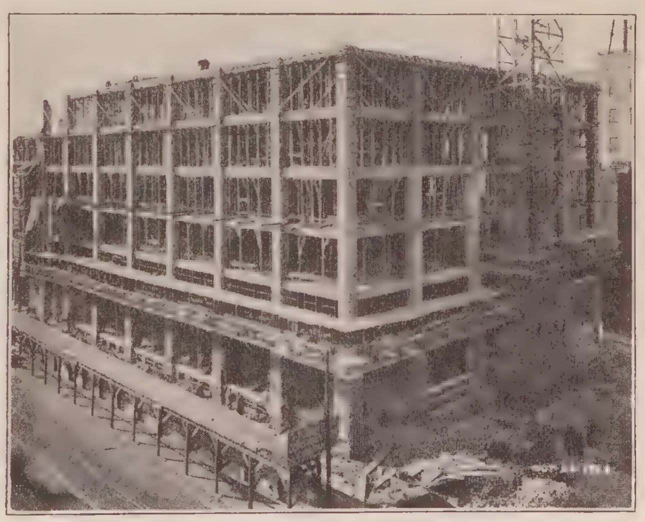
Here is the measuring device installed in the water barrel that insures the correct water-cement ratio at but little expense or attention

carried by the 4x6s at the columns. Next, the drop-heads, which were made in two sections, were dropped in place from above and rested on the upper 2x10s that were carried by the lower 2x10s nailed to the column shores. The final step was the insertion of the filler strips between the drop-head and the floor form, as shown in the drawing, and the forms were then ready for the steel, which was lowered into the columns by means of a small hand derrick.

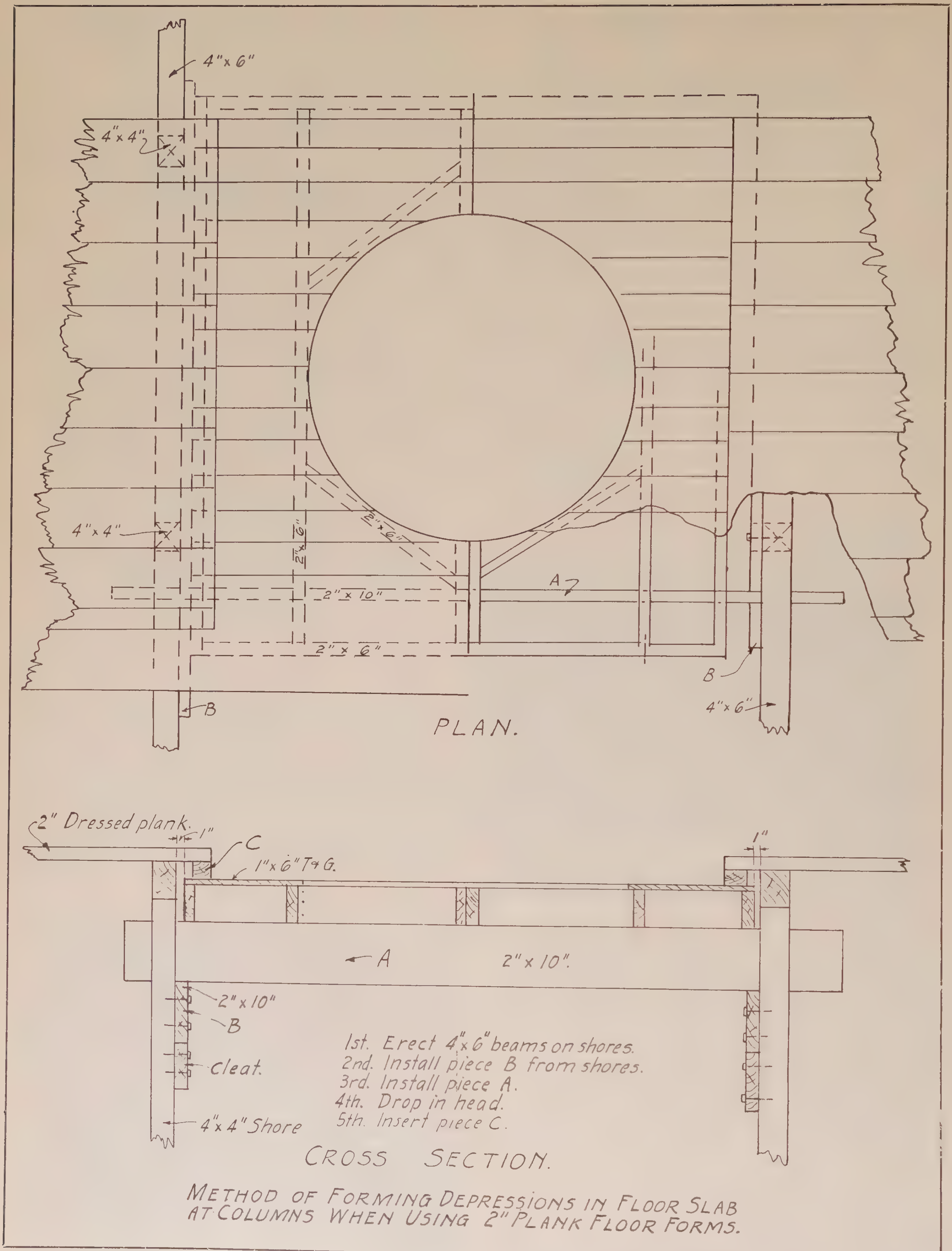
In stripping these forms, the floor forms were lowered without disturbing the permanent shores, and lowered safely, by means of the rope and shore device universally used by that contractor. Before floor forms were stripped, however, the stripping gang first knocked out the 2x10s under the drop-heads, letting these forms fall to the floor. The column shores were taken down at the same time, and then the floor forms could be easily stripped. As is usual, the column forms were left until the last. This stripping was done within three weeks of placing the concrete, and the forms then moved up to the story then being formed. It proved to be a very workable scheme for a flat slab job, and led to a worthwhile saving.

Handling the Materials

The concrete mixer was located in the basement, and discharged into the skip of the ordinary concrete hoist. Here the batch was elevated and discharged into a field hopper, from which the concrete was discharged into buggies for transportation to the forms. A man on the tower passed along the signals from the concrete foreman on the slab to the man at the mixer. The proportioning was done on the street, by means of wheelbarrows and a water barrel equipped with a special measuring device was installed on the same level to supply the mixer with just the right quantity of water for each batch. The aggregates and cement were delivered by truck and stored on the street, and the aggregates were proportioned on the



Progress to October 26, with one floor to go, and the masons already on the second floor. Note the safety scaffold with wire enclosure and overhead protection as prevention of accidents. The job is now under roof and most exterior work is completed



1st. Erect 4"x 6" beams on shores.
2nd. Install piece B from shores.
3rd. Install piece A.
4th. Drop in head.
5th. Insert piece C.

METHOD OF FORMING DEPRESSIONS IN FLOOR SLAB AT COLUMNS WHEN USING 2" PLANK FLOOR FORMS.

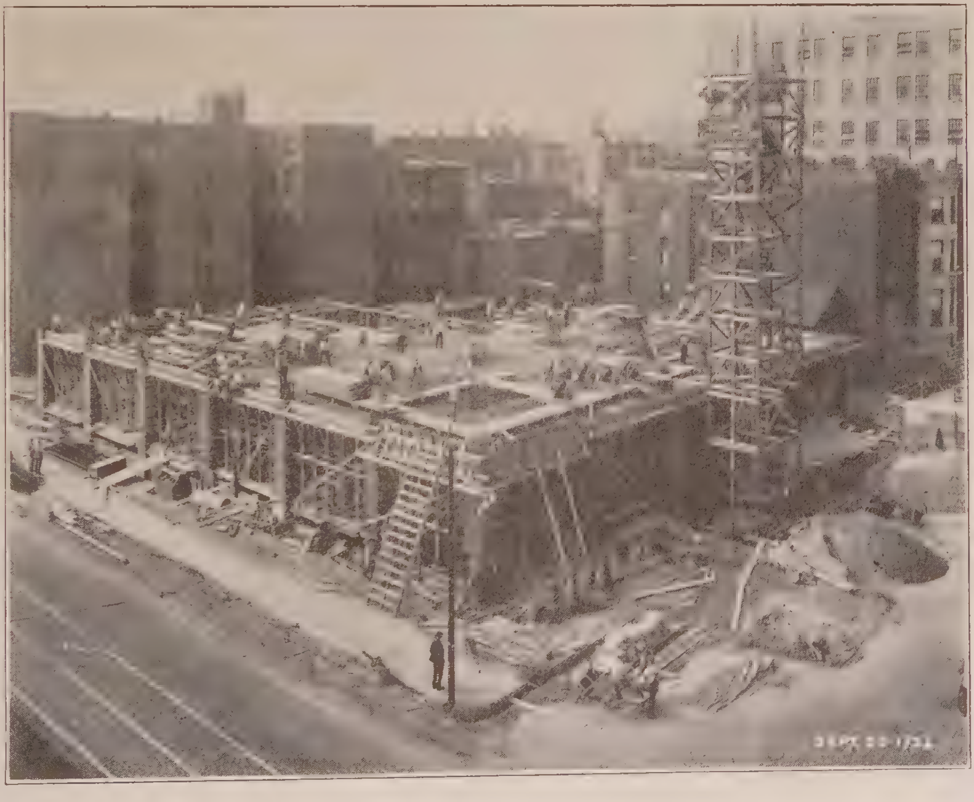
Detailed drawing of the drophead form system used on the job. First, the 4x6s are erected on the shores. Next, piece B is installed from the shores. The piece A is laid across piece B. The two-piece drophead form is then dropped in place. Piece C is finally inserted, and the form is ready for the steel pavement by first spreading out the required quantity of gravel, on top of this the sand, and then came the cement. The wheelbarrow men would then load from this pile and deliver the materials to the mixer as required. A material hoist on the alley side carried lumber and steel to the work.

The water measuring device, as shown in the illustration, consisted of an ordinary water barrel, in which was hung a scale graduated in gallons. A rod on the lower end of which was fastened an ordinary water closet float, and on the other end of which was a pointer operated in two guides fastened to the scale. This device was installed in the barrel in such a way that the barrel, when full, caused the pointer to register zero and, as the water was discharged, to show the discharge in gallons as the float fell with the water. A valve in the upper intake pipe and a valve in the lower outlet pipe afforded easy control. A baffle, placed in the bottom of the barrel between the intake and the indicator, prevented the surge caused by inflowing water from giving an erroneous reading of the indicator. The mixer man could thus very easily fill the barrel to the zero reading, and then let just the required number of gallons of water into the drum, stopping the flow as soon as the indicator showed the right quantity.

Concrete Proportions

The mixes used called for a mixture of aggregates to a fineness modulus of 6.40, using a sand with a fineness modulus of 3.20 and a gravel, graded to 1½ inches, with a fineness modulus of 7.20. The cement factor ranged between 1.42 and 1.45. The 2,000-pound concrete was made with these materials with the use of 7½ gallons of water per sack of cement, and tests showed workability enough to give a slump of 7 inches for the average batch. The 3,000-pound concrete was obtained by using 6½ gallons of water per sack of cement without otherwise altering the mix. It was found that the sand usually contained about ¼-gallon of water per cubic foot, and this had to be corrected for at the mixer. By means of these two mixes, a two-course floor was obtained simply by using the dryer and stronger batches in the topping, while the wetter mix gave the required finish on the ceilings. After floating, this floor was given a further topping of a dry mixture of two parts sand to one part cement, which was spread on immediately with the shovel with a sweeping throwing motion. Wood float and trowel were used in finishing the floor, and a floor hardener then applied, after which the entire area was covered with about an inch of fine bank sand. This sand layer was kept wet for the full curing period. The advantage of this type of sand is that it in itself does not mar the floor, it offers excellent protection against the rain, and protection against falling form lumber and other wear and tear to which the new floor is always subjected during the construction operations that follow the time at which it was laid.

The Paidar Building is being constructed for the Emil J. Paidar Company, manufacturers of barbers' supplies. It will be used for manufacturing, storage, display, and office purposes entirely by the owners. The structure is seven stories high, but designed for the addition of four more in the future, and is of reinforced concrete flat slab construction with brick filler walls. The general contractor was the Turner Construction Company, with C. H. Schwertner as superintendent. S. N. Crowen was architect and engineer.



Progress to September 20, with concrete about to be placed on second floor, forms being erected, and steel being placed

Here and There

Some Random Notes on Visits with Concretors in the Field

IT seems each year as if it were impossible to have a better Road Show than the present one. And yet when Road Show time comes around, there it is, bigger and better than ever before. This year's show was a wow. There were more exhibitors and it seemed as if they tried harder to make the exhibits interesting and helpful.

* * *

YOU get an idea of the important place concrete roads occupy in this big road-building game when you walk through the Chicago Coliseum where the exhibits are. Almost every piece of equipment has some application to concrete road construction or maintenance. And the program of the American Road Builders Association, which is held in Chicago at the same time, increases that impression because a large percentage of the papers and discussions is devoted to concrete roads and pavements.

* * *

THE program of the American Road Builders Association was, as last year, divided into two sections—one for the engineers and one for the contractors, so that each group could devote as much time as possible to a discussion of their individual problems. The convention opened and closed with a general session attended by both engineers and contractors.

The program was arranged to give everyone attending some items of particular interest. The Engineers' Problems sessions included discussion of the following subjects: Work preliminary to construction; construction; operation and maintenance. The contractors discussed: Contracting as a business; practical operating methods; enlargement of contractors' field benefiting political subdivisions.

* * *

THE exhibits at the Coliseum illustrate forcibly the steps taken in recent years in building better concrete highways. Starting with the proportioning plant, there are several very practical aggregate measuring devices. They are so made that it is impossible not to measure the aggregates accurately. You can set the rigs for any proportions desired and then they check the proportions mechanically. You can measure your aggregates precisely either by volume or weight.

Proportioning plants like these were first developed on road work, but they can be used just as well on other kinds of jobs. They would go fine in products plants, for instance, and they fit in fine on structural jobs, too. If you design a good mix and proportion it accurately, the first step in making good concrete is taken.

* * *

THEN the mixers. They were there in force. Big pavers and smaller mixers for bridges and culverts. They, too, showed the tendency toward quality control. New developments in water-measuring devices on concrete mixers of all sizes are another indication of the desire of manufacturers to co-operate with engineers in securing better concrete on the job. These devices are making the application of the water-cement ratio principle practical under field conditions and are thus making a notable contribution to the improvement of the quality of field concrete.

THERE were, of course, many exhibits of the smaller labor-saving devices. Road forms, reinforcing, joint material, finishers, machines for cutting joints, etc., all were represented. Admixture manufacturers, also, had attractive exhibits in which they showed methods of adding their products to the mix. Traffic control equipment displays indicated the importance of this equipment in the modern road and street development program.

* * *

AS usual, the U. S. Bureau of Public Roads exhibit was one of great educational value. It presented the results of experience and research in highway construction, graphically displayed in charts and illustrations. The subjects represented included highway financing, sub-grade surveys, grading economy, stage construction, pavement planning, efficient concrete mixing, and traffic surveys. The display featuring efficient concrete mixing was of exceptional interest to the concrete road builder. It showed by means of a clock dial and illustrations the time required to perform all the necessary operations in loading, mixing and discharging a batch of concrete on the sub-grade. With a one-minute mix, the operation was completed in 75 seconds.

* * *

ANOTHER exhibit of an educational nature that secured a lot of attention was the slump test display at the booth of the Portland Cement Association. Concrete of various consistencies, with various slumps, were illustrated by hardened samples as they came from the slump cone. With each sample was a card bearing the water-cement ratio of the sample and its compressive strength.

* * *

OF course, there was the big Road Builders' banquet. Gutson Borglum, the noted sculptor, was the principal speaker. He suggested improvements in the plans for the 500-foot road that would extend from coast to coast as proposed by Senator Coleman Du Pont of Delaware in a bill now before Congress. Mr. Borglum suggested that the roadway be separated into four traffic lanes, two going each way, one of each for traffic moving at less than 30 miles an hour and the other for traffic of greater speeds. The cost of this road is to be paid for by renting concessions along the right of way.

* * *

IT was a pleasant surprise to see many types of equipment represented that fit into the structural and products field, also. In fact some of the exhibitors find their principal market in other fields than highway construction. There was even one concrete block manufacturer who had a booth.

The presence of these manufacturers at the Road Show raises the question of whether or not it would not be well to have another show devoted to displays of *all* types of concrete equipment. Something like the old cement show used to be, for instance. It would give manufacturers of all types of concrete construction equipment a logical place to exhibit their equipment and machines—from the road paver to the pallet manufacturer, from the aggregate bin to the block machine.

That is only a suggestion. We would like to know what you think of it.

Reinforced Concrete Buildings Withstand Cuban Hurricane*

Investigation Shows That Reinforced Concrete Structures Again Came Through the Hurricane With a 100 Per Cent Record—Steel Buildings Encased in Concrete Also Have Good Record—Some Specific Examples—Building Regulations in Havana—Conclusions

THE violent hurricane that devastated western Cuba and the Isle of Pines on October 20, 1926, passed in a general direction from southwest to northeast, with the center of the disturbance passing about 15 miles southeast of Havana. The wind blew with hurricane velocity for about 12 hours, continuing from about 2 o'clock in the early morning of October 20 to about 2 o'clock in the afternoon. At first the wind blew from the east, but at 5 o'clock in the morning it shifted to the northeast. After 10 o'clock in the forenoon there was a sudden shift to the north, and still later to the northwest.

The heaviest blow occurred from about 9:30 to about 11:30 in the forenoon, but before that time the aerometers at the National Observatory had been blown away, at the instant when they registered 96 miles an hour. The velocity grew considerably higher after the destruction of the aerometers. The consensus is that the Cuban storm reached a velocity of from 120 to 130 miles an hour and that it was of a severity equal to that of the Florida hurricane of September 18, 1926.

The probable force of the wind, expressed in pounds per square foot, can be estimated only after analyzing the theoretical lateral resistance of the structural frames of buildings which were in exposed locations. A number of modern buildings in Havana, ranging in height from seven to ten stories, are surrounded by older buildings of two or three stories. The taller modern structures were consequently subjected to the force of the wind for nearly their full height. Inasmuch as no damage occurred to any of these buildings, an analysis based on the ultimate strength of the structural frame might give us some idea of the force of the wind.

Not all buildings in Havana are designed for the same assumed wind pressure. One large firm of engineers designs against an assumed pressure of 30 lbs. per sq. ft.; but the city building regulations are not specific on this point, and the building department is known to have accepted designs that were computed for pressures less than 30 lbs.

Preparation for the Storm

Warnings of the storm's approach were first announced on the morning of October 18, and on the following morn-

View across the neck of the harbor entrance, taken on the afternoon of October 20, shortly after the storm began to subside ing the warnings were applied definitely to Havana and western Cuba. Announcement was made that the hurricane might be expected shortly after midnight, in the early hours of the twentieth. All day and evening on the nineteenth the people of Havana were busily preparing for the storm, boarding up plate glass windows, securing shutters on doors and windows, getting merchandise under cover, putting water craft in the safest places available, attaching guy wires to derricks and construction towers, and taking such other precautions as previous experience dictated. By midnight the city was fairly well prepared for the storm.

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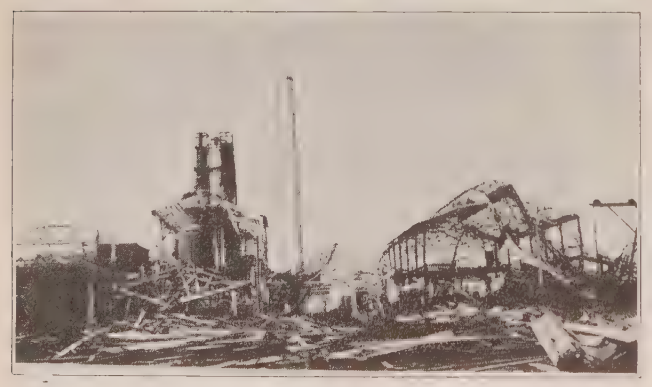
*Condensed from a Report by N. M. Stineman

The exact loss of life will probably never be known. Estimates place the loss at a figure approximating 500. Of this number about 55 were lost in Havana, not including the deaths in the harbor. The property loss is variously estimated at amounts approximating $100,000,000. The greatest loss of both life and property occurred in the smaller towns and villages in the open country.

The Ward Line Pier. One of the finest examples of reinforced concrete waterfront construction in Havana Harbor. When the 6,000-ton steamer Barcelona crashed into the pier during the storm, it laid up the steamer but did not damage the pier

Harbor Structures

Harbor structures at Havana, such as docks and piers, are of two general types. The older structures are of wood, many of which were either damaged or partly destroyed. Several were almost completely destroyed. The newer type of waterfront structure, built in compliance with a Federal law applying to all harbor work in Cuba, are supported on reinforced concrete piles, over which are sub-structures of reinforced concrete or of concrete-encased structural steel, with the former type predominating. The super-structures are of reinforced concrete. Among the newer type of harbor structures neither sub-structures nor super-structures suffered any damage at all.



The reinforced concrete chimney at this sugar mill at La Julia, near Havana, is all that is left of the plant

Wooden super-structures on the docks and wharves were quite generally either damaged or destroyed. Most notable among them is the Atares warehouse, owned by the American and Cuban Terminal Company. The main warehouse and the auxiliary buildings, all of which were of wooden construction with corrugated iron roofing, were completely destroyed. Other damaged wooden harbor structures were found in many sections of the waterfront.

Among the reinforced concrete pier and wharf structures, none of which suffered any damage, are the San Francisco Pier, the Machina Pier, the Santa Clara Pier, the Ward Line Pier (illustrated), and terminal warehouses at the four piers just named. All these are splendid examples of reinforced concrete construction, and show evidence of good design and supervision.

Chimneys

Tall reinforced concrete chimneys made a praiseworthy record in this storm, whether considered from the standpoint of their own performance or in comparison with the performance of tall brick chimneys and steel stacks.

In the entire area 32 tall concrete chimneys of the industrial type were not damaged in the slightest. Four concrete chimneys with very thin shells and light reinforcement, all designed and built by the same concern, were damaged. One of them, at the Toledo sugar mill, had its upper part blown off. The sugar mill itself was completely destroyed. Another one, at the Mercedita sugar mill, was badly damaged, while two at Gomez Mena were damaged to some extent. These four chimneys are the only failures or part failures among reinforced concrete structures of any kind whatever in the entire storm area of Cuba.

Brick chimneys failed to perform in a creditable manner. An incomplete check-up disclosed eight large brick chimneys destroyed, one badly damaged and one slightly damaged, although the total number of brick chimneys in the storm area is certainly no greater, and probably not as great, as the total number of concrete chimneys.

Among steel stacks the number of failures was very large. No attempt was made to compile a record.

Quality of Concrete Work in Cuba

Interviews with American and Cuban engineers in Havana indicate that concrete as a rule is of no more than fair quality, due to somewhat inferior aggregates. Sand and gravel are obtained largely from the ocean beach. Some river sand and gravel are used, but the river product sells at a higher price without producing much better results.

The Frederick Snare Corporation, one of the largest construction companies, conducted some tests from which they obtained the best results with a mixture that varied to some extent, but averaged about 4½ sacks of cement, 6 cu. ft. of fine Terara white sand, 6 cu. ft. of quarry grits, and 16 cu. ft. of crushed stone, one-third of which was ¾-inch stone and two-thirds was 1½-inch stone.

Old and Modern Buildings

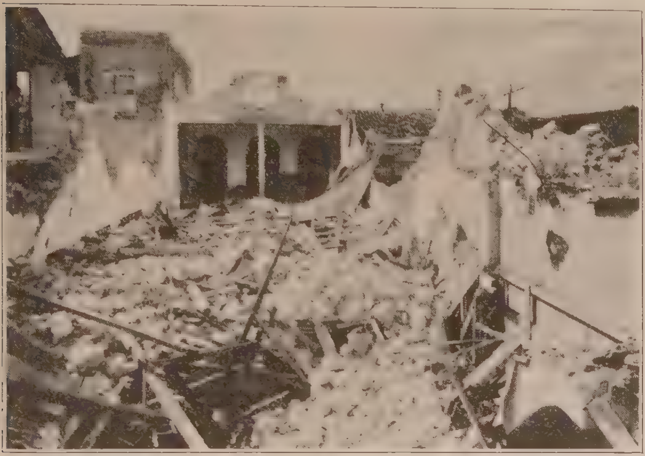
Buildings in Havana and vicinity must, for the purpose of study, be separated into two general classes: namely, those built before the days of modern development in Cuba, and those built under the influence of that development.

The Havana skyline has no resemblance to the skylines of large cities in the United States. Very few buildings extend above four or five stories. Modern reinforced concrete and concrete-encased steel buildings vary in height up to 10 stories, but only four buildings (two of each type) reach the extreme height. There is now under construction a concrete-encased steel building for the

Cuban Telephone Company that will be 12 stories high, including a two-story tower.

Older Office and Mercantile Buildings

Very few of the older office and business buildings are as much as five stories high, while most of them range from two to four stories. The Manzana de Gomez, five stories high and covering one block, is probably the largest office building in Havana in the matter of floor space. Individual stories in these buildings, however, are much higher than in corresponding buildings in the United States. For example, the third story of the Manzana de Gomez is 17 feet from floor to ceiling. Even the modern buildings have much higher story heights than in the United States. In the Sevilla-Biltmore hotel, to cite one instance, the upper floors are 13 ft. 3 in. from floor to ceiling. The purpose of the high ceilings is to permit circulation of air during hot weather.



Destruction of a wall of the primitive concrete described in the text. These walls consisted of small stones laid in a mortar bed of clay and lime, plastered outside and inside

These older buildings are of very heavy construction, but not of particularly good workmanship. Their low and uniform height and their massiveness provide good resistance to storms.

Older Dwellings

Most of the older dwellings, like the older office and mercantile buildings, are built of stone masonry, coated with stucco. It may be said that all buildings in Havana are coated with stucco, for the number not so treated is negligible. This stucco, or plaster, formerly was made of a mixture of lime, clay and sand. The mixture now used is lime, portland cement and sand. An older and more primitive form of masonry consists of very thick walls made of a mixture of clay and lime, into which small stones were placed, after which both the exterior and the interior were plastered. This construction is shown in the destroyed walls in an accompanying illustration. It produces a wall of soft masonry, not strong, but it is heavy and provides good insulation against heat.

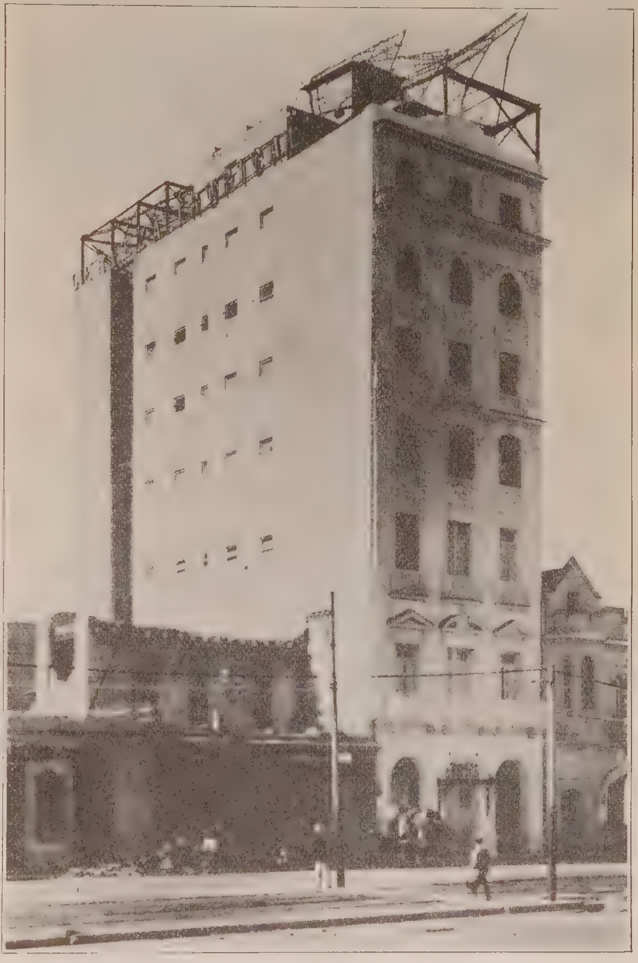
The prevailing floor surface in buildings of all types is tile, either clay or cement tile, the latter made in Havana by workmen well skilled in the trade.

Flat roofs are surfaced with flat tile, and sloping roofs with Spanish tile. The latter were in a number of instances blown off during the hurricane but the sheathing remained in place. There was comparatively little unroofing in the city except where entire sections of buildings were destroyed.

Modern Buildings

Modern buildings in Havana are rapidly coming into prominence. Like their predecessors, all modern buildings of architectural pretension have their exteriors finished in stucco. The effects obtained are wonderfully pleasing, as shown in the detail of the Hotel Astor, a 10-story reinforced concrete building (illustrated). In this detail the mouldings are cast in place and the balusters are pre-cast. The first story, the shorter street front and the corner bays are smooth stucco, marked off in courses, and the balance of the exterior is a rough-cast stucco.

Almost without exception the modern buildings in Havana have either a reinforced concrete structural frame or a concrete-encased steel frame, the proportion being about 40 per cent of the former and 60 per cent of the latter. In not a single instance did a reinforced concrete building suffer any structural damage. This is true of the areas outside of Havana as well as those within the city.



The perfect performance of this concrete apartment house, 7 stories high, is typical of the performance of reinforced concrete of all kinds in the hurricane zone. Exposed to both sea and storm, it suffered no damage aside from broken windows

Completed steel frame buildings of the office and residential class likewise suffered no damage. However, a four-story apartment building of the steel frame type, under construction at the corner of Twenty-Fifth Street and the Paseo, was completely destroyed. Steel industrial buildings of the transverse bent type, employed extensively in the construction of sugar mills, registered a number of costly failures.

Among the modern reinforced concrete buildings in Havana, the Echeverria Apartment Building, at 16 Marina Street (illustrated), deserves special mention. This building, a long, narrow seven-story structure located on the ocean front, was exposed on all sides to the action of both wind and sea. The building was struck first on one side, then on the front, then on the opposite side. The stone buildings next to it were destroyed, but the apartment building was not damaged beyond the breaking of a few windows and the destruction of framework supporting signs on the roof. The Carrera Justiz Apartments, facing the ocean front on the Malecon Drive, is another splendid example of reinforced concrete construction. This structure has the distinction of being the first modern apartment built in Havana. It is also on the ocean front, but it was not damaged in the storm.

The Hotel Astor, a 10-story building with reinforced concrete structural frame and floors, also suffered no damage even though the building was exposed to the storm for its full height. The exterior of the first floor, the entire front and the end bays of the long side are smooth portland cement stucco, marked off in courses. The mouldings are cast in place and the balcony balusters are of precast concrete

Moderna Destiladora. This building has a reinforced concrete structural frame with filler walls of brick. Two of the filler walls were blown out but the building suffered no other damage. The reinforced concrete chimney was undamaged

Building Regulations in Havana

Because of the generally good record made in the storm by modern buildings, the logical inference is that the officials in charge of the inspection of structures must have the situation well in hand. This is true, but not in the sense that might be supposed. The secret lies in the fact that the designer of a building is held directly responsible for its structural safety. This responsibility has been established, not through a clause in the building laws, but through cases actually tried in the civil courts.

Under this system the municipal inspection department has very little field inspection to do. The designer, knowing that he will be held responsible for defective work, sees that honest construction goes into the building. *He* provides the necessary field inspection.

This method of handling the troublesome question has led to the growth of a system peculiar to Havana. Instead of having one individual or firm acting as architect, another as structural engineer, and a third as contractor, these three functions are all centered in one person or one organization. This serves further to place the responsibility for structural safety.

Conclusions

The conclusions to be drawn from the effects of the Cuban hurricane may be summarized as follows:

1. Under present-day construction costs the concentration of strength in a continuous structural frame is the logical type of construction in regions subject to violent storms.

2. Structural frames of reinforced concrete or of structural steel encased in concrete can be designed and built to resist the most violent storms thus far experienced. Structures which are reasonably well built and are properly designed for an assumed wind pressure of 30 lbs. per sq. ft. will have sufficient reserve strength to resist a storm of the violence of the Cuban hurricane.

3. Reinforced concrete construction of no more than average quality made a record that was all but perfect.

4. The structural steel frame, *when encased in concrete*, is virtually as effective as the reinforced concrete frame.

5. Buildings of the steel mill type can be built to resist hurricanes if fitted with steel sash and wire glass, to keep out the wind, and if the curtain walls are built of a material that will add to the rigidity of the structure.

6. Clay brick proved itself entirely unsuited for tall chimneys in hurricane areas.

7. Stone and clay brick masonry laid in the ordinary way cannot safely be depended upon to resist violent hurricanes unless the individual masonry units are of good quality, and unless a high grade of workmanship and a good quality of mortar can be assured.

8. A fundamental requirement is that the wind must be kept out of the interior of buildings. Windows protected by strong shutters will go far toward accomplishing this purpose.

9. Making the designer of a building responsible for its structural safety has been an important factor in the prevention of unsafe construction in Havana.

10. The exposed situation of the taller modern buildings in Havana will give an excellent opportunity to estimate the outside limit of the force of the hurricane against structures, expressed in pounds per unit of area.

The Concrete Masonry Situation in Florida

Unbiased Studies of Performance and Improvement Within the Industry Are Restoring Confidence

THERE is no probability of adverse amendments to building codes that will serve to restrict or prevent the use of concrete hollow block in the cities of Florida. Building officials know very well what the trouble was in most instances where concrete block walls fell, and they think they know how to prevent such construction in the future.

Bearing walls of both concrete block and clay tile will likely be required to have wall girders of reinforced concrete all around the building at each floor level. This was a method advocated at a meeting of building officials at Fort Pierce on December 3 by George L. Pfeiffer, supervising architect, Southeast district, Florida Hotel Commission. L. F. Fletcher, building inspector of Orlando and president of the Florida Building Officials' Conference, said Mr. Pfeiffer's suggestion was in line with the opinion of the members of the building code committee of the Conference.

It is probable also that in their proposed uniform building code the B. O. C. code committee will require concrete block and clay tile to be laid wet. The Coral Gables code has already been amended to that effect. In Miami the building department expects to include such a requirement in the new code. The tendency to require block to be laid wet arises from the general opinion among building officials that while block failures were almost invariably at the joints, poor quality in the unit played its part nevertheless. The theory is that the poorly made units were highly absorptive, as a consequence of which they promptly absorbed much of the water in the mortar as they were being laid, thus leaving insufficient moisture to produce proper setting and bonding even where the mortar was reasonably good. The mortar used in laying concrete block and clay tile in Miami consisted in most cases of a lime mortar, with cement added to the amount of 10 per cent of the weight of the lime. This, of course, is not a suitable mortar for concrete masonry.

Block Now Carefully Tested

The block situation is rapidly becoming cleared up. At Miami, since April, 1926, test blocks have been taken *from each job*, and block must average not less than 800 pounds per square inch over the gross area. At Tampa, Orlando, St. Petersburg and other cities the building inspectors have the situation well in hand. In all these places the fly-by-night block maker who sold so much block during the building boom has gone out of business. In addition to all this, the concrete block industry is in a fair way toward being organized as a state association. This organization is expected to co-operate with city building departments in keeping up the quality of the product.

It is unquestionably true that the vicious and misleading propaganda mailed out by competing material interests has served as a boomerang, so far as building inspectors are concerned. The inspectors have had their desks swamped with this propaganda until they are sick of it. As one man in the Fort Pierce meeting said, everyone who knows anything about building construction knows that a man with a camera could go into the Miami region and get pictures showing that any building material was either a success or a failure. Of course, these things have made their impression on the general public, but not on the people who deal with the construction and inspection of buildings.

Any publicity on the performance of concrete block would do well to deal with the subject in the form of an engineering analysis. That is, it should be confined to an analysis of the causes of failure where failure occurred; an analysis of the reasons back of the excellent performance of block in Coral Gables; a statement of steps taken and being taken to insure better quality of product and of construction; and, in general, emphasizing the fact that the failures that occurred were essentially caused by poor workmanship and that the *total number* of failures is due to the extensive use of concrete block by the speculative builder. Anything in the nature of propaganda designed to gloss things over will have a bad effect on building officials, regardless of the favorable effect it *might* have on the general public. But even the building public may be impressed more favorably with a clean-cut statement of why conditions were not what they should have been, and a statement of steps taken to correct the former undesirable conditions, than by more propaganda such as some material interests have put out.

Regarding the proposed or actual changes in construction practice affecting concrete block, it is not easy to suggest what effect they may have on the block industry. The proposed reinforced concrete wall girders at each floor level may add so much to the cost as to discourage the use of block. There may be other means of accomplishing the same purpose at less cost, as, for instance, the proper anchorage of floors and roofs to walls, the introduction of pilasters or cross walls, better supervision of construction, and so on.

One safe prediction is that the improvement in the block industry, coming largely from within the industry itself, will do much to restore confidence in the material.

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*Condensed from a Report by N. M. Stineman

Central Mixing Plant for Kansas City

A central mixing plant, selling ready-mixed concrete for all classes of concrete work, has been built and is being operated by the W. A. Ross Construction Company at Summit Street and the Terminal tracks, being served by the Terminal and Frisco. This is a new industry locally, and was announced following the acquisition of more than three acres of land by the R. P. Realty Company.

Summary

The Constitution of Portland Cement Clinker

In this issue the last installment of the digest of the literature on the subject, "Constitution of Portland Cement Clinker," is presented.

The series of articles has summarized and tabulated the many important contributions that have been made to the present knowledge about the constitution of portland cement. These reviews, while not exhaustive, have been fairly representative, presenting all the important researches and opinions chronologically under the key subdivisions of the subject.

Beginning with the studies of Smeaton, Higgins and Vicat, the review carried the reader through the period of the discovery of portland cement by Aspdin in 1824, and presented first the chemical theories as to the nature of this new material that was destined to play such an important part in the construction industry.

Most of these early theories were based on little more than conjectures. It was not until Henri Le Chatelier began his researches that the scientific era of research on this subject began. With his keen perception and thorough work, Le Chatelier discovered and tabulated many findings that are today acknowledged as facts. He was among the first to propose definite formulas for proportioning raw materials to secure cements with the desired qualities.

Following Le Chatelier came other investigators, all contributing to the sum total of the knowledge of the nature of portland cement. Soon there was enough material on hand to formulate various definite theories and to compare the opinions of the investigators. The hypothesis of solid solution was one of these theories upon which many investigators offered opinions.

Working independently, the scientists strove to segregate and identify the many compounds existing in portland cement. In attempting to express these compounds in constitutional formulas, the investigators found themselves on comparatively unexplored ground. Much painstaking effort along these lines resulted in little definite accomplishment.

Another important phase of the problem was to arrive at a definite understanding of the reactions and the sequence of reactions taking place during the burning process in the kilns. Complete researches on this subject had never been undertaken, though some independent studies had been made. The several methods that have been tried by investigators for determining the heats of formation of the compounds found in portland cement were among the points discussed in the series.

Studies of phase equilibria have helped to clear up many of the objections raised regarding the results from previous researches. Yet opinion is still divided on many of the most important phases of this subject.

Thus the matter stands now. A wealth of scientific data is at hand. The marvel is that scientists could gather such a volume of authoritative material with the crude methods and equipment that were then available. Yet with all this work, which has been of inestimable value to manufacturers and users of cement in the past, there are still many instances under present day conditions when the facts at hand seem inadequate. More exact knowledge is necessary for the final solution.

The assembling of this needed data is the task that the cement industry has now set itself. Through the Portland Cement Association fellowship at the U. S. Bureau of Standards an effort is being made to clear up these incomplete and disputed questions, so that complete knowledge on the constitution of portland cement may be made available.

A review of the present knowledge, gained through past researches and a tabulation of the facts and opinions presented by investigators up to the present time, was necessarily one of the first steps in this new research. The compilation of such a review was the object of the series that is closing with Part VII, presented on the opposite page of this issue.

The Constitution of Portland Cement Clinker*

Part VII of a Digest of the Literature on This Subject—Opposition to the Phase Rule Criteria — Views Held by Dyckerhoff and Nacken—Recent Studies on the Constitution of Portland Cement—Changes During the Burning Process—Retrospect and Conclusions

By R. H. BOGUE

Part VII.—Phase Equilibria and the Modern Viewpoint

(Conclusion)

NOTWITHSTANDING the evidence of the phase rule, many investigators, especially in Europe, have continued to depend on the more empirical data obtained by the earlier school of research.

Kuhl[65] has contended that the argument of Dyckerhoff on the nature of alite is incompatible with chemical analysis. On the assumption that the lime combined (1) with the SiO_2 to form $2CaO.SiO_2$, (2) with the Al_2O_3 to form $3CaO.Al_2O_3$, and (3) with the Fe_2O_3 to form $3CaO.Fe_2O_3$, there would still remain about 14 per cent of lime as free CaO. Kuhl maintains that there is no free CaO in properly made cements.

Kuhl further adds:

> 1. In thin sections of portland cement clinker there are no regular crystals of lime-rich aluminates, therefore the clinker contains no free aluminates.
>
> 2. Clinkers which contain appreciable quantities of free dicalcium silicate must dust; normal clinker shows no sign of dusting.
>
> 3. Dicalcium silicate sets and shows hydraulic hardening but according to Schott does not nearly approach the hardness of portland cement; therefore, it cannot be an important hardening agent.
>
> 4. Schmidt and Unger analyzed large alite crystals in which they found 4 to 6 per cent of Al_2O_3.
>
> 5. In old hydrated cements we find equal decomposition of the alite crystals; not a solution of the aluminates which surely must take place if free aluminates are present, for they are very reactive to water.

Kuhl accordingly holds to the belief that the important constituent of clinker consists of "a lime-rich system whose composition approaches that of tricalcium silicate, and perhaps in certain cases is tricalcium silicate, but under normal conditions it is not free from Al_2O_3." The alite may be regarded either as "an isomorphous mixture of tricalcium silicate and tricalcium aluminate," or as "a solution of free lime in an isomorphous mixture of dicalcium silicate and tricalcium aluminate."

Schmidt[68] believes with Kuhl that alite is a solid solution of $3CaO.SiO_2$ and a calcium aluminate, and presents evidence based on a number of chemical analyses made by Le Chatelier, by Tornebohm, and by himself and Unger. These analyses show that, when the SiO_2 is calculated as $2CaO.SiO_2$, there remain about 24 per cent of CaO to be combined with the Al_2O_3 and Fe_2O_3. Since this is an excess of what could be accounted for by such combination, he argues that the SiO_2 must be combined as $3CaO.SiO_2$. But since Al_2O_3 was always found in the alite crystals, Schmidt believes that the alite is a solid solution.

Dyckerhoff and Nacken

These arguments were further refuted by Nacken and Dyckerhoff.[69] They caution against assumptions not supported by experimental evidence. Since the system $CaO.Fe_2O_3.Al_2O_3$ has not been investigated, one may not state what compounds may be formed in this system; $3CaO.Al_2O_3$, however, has been found by Dyckerhoff in synthetic clinker. They point out that the presence of aluminates effectively prevents $2CaO.SiO_2$ from dusting. They recall that Schott separated his two forms of $2CaO.SiO_2$ by sieving, and since the gamma form is nonhydraulic, he may have obtained a product contaminated with this inactive form, which would account for the low strengths obtained by him. They contend that the crystals obtained by Schmidt and Unger by the actual fusion of pure raw materials are not the alite crystals obtained by the lower-temperature sintering of a cement raw mixture. The former may indeed be a ternary compound, but it is not the alite of portland cement. And, finally, they refute Kuhl's assumption that a crystalline material must be soluble or insoluble "as a whole," making impossible the solution of one part, while leaving another part as an insoluble residue.

The controversy seems not to have been settled by this exchange of ideas, but rather to have left in the minds of the chemist a confusion of ideas, partly accepting, partly rejecting the theories of the several contenders. Thus

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*Paper No. 3 of the Portland Cement Association.

[65] Hans Kuhl, *Tonind. Ztg.*, *38* (1914), 537; Kuhl and Knothe, "The Chemistry of Hydraulic Cements," Leipzig, 1915; *Protokoll* Veriens Deut. Portland Cement Fab., *44* (1921), 109; *45* (1922), 98; *Zement, 13* (1924), 512.

[68] Oscar Schmidt, *Zement, 13* (1924), 543.

[69] R. Nacken and W. Dyckerhoff, *Zement, 13* (1924), 626, 649.

Biehl[70] finds, by correlating his experiments with theory, that one may have in cement clinker transition compounds, solid solutions, etc., of all possible stages ranging from beta $2CaO.SiO_2$ to Janecke's compound $8CaO.Al_2O_3.2SiO_2$. Belite and celite he regards as "only members of an isomorphous series in which iron may occur in varying amounts."

Recent Study on the Composition $8CaO + Al_2O_3 + 2SiO_2$

Dyckerhoff[67] has recently reported an investigation on the three-phase system $CaO.Al_2O_3.SiO_2$. A significant feature of this report is found in the rediscovery of the compound $8CaO.Al_2O_3.2SiO_2$. This is similar in composition to that reported by Janecke, but it was doubted by Dyckerhoff that Janecke actually obtained this compound, since the conditions for its stability he finds to be different than those reported by the earlier investigator.

This ternary compound is stated by Dyckerhoff to consist of "fine needle-like aggregates, more rarely elongated prisms." To obtain a homogeneous preparation, the material which was fused in the oxyhydrogen flame and contained some free CaO, was heated at 1200° for 72 hours. At the end of this time he obtained "a completely homogeneous mass in which only this one crystal form was present." Dyckerhoff states that

> The optical constants are so close to those of tricalcium silicate that differentiation by optical means becomes difficult. The somewhat lower refractive index of the compound $8CaO.Al_2O_3.2SiO_2$ serves as the only means of doing so.

A specific gravity determination gave a value for this compound of 3.090 against a value for the mean of the compounds $3CaO.SiO_2$, $3CaO.Al_2O_3$ and $2CaO.SiO_2$ (calculated) of 3.190.

Changes During Heating

The complicated course of the changes taking place on heating a mixture of the proper composition is shown by Dyckerhoff. He finds, at 1200°, $2CaO.SiO_2.Al_2O_3$ and CaO.

> Upon further heating, the highly basic aluminates form, the eutectic of which melts at 1395°. Meanwhile $2CaO.SiO_2$ dissolves CaO. The preparation is in this form at 1400°. At 1600°, $3CaO.SiO_2$ forms with some $2CaO.SiO_2$ and $3CaO.Al_2O_3$. At 1800° the whole preparation consists of $8CaO.Al_2O_3.2SiO_2$. Such a complicated course of mineral formation has never before been studied in inorganic chemistry. One usually assumes that, upon heating components in the proper proportions, the compound which is expected forms. It would be interesting to find out whether in any other system a similar formation takes place.

These studies were then carried over to synthetic and commercial cements. A mixture of 66 per cent CaO, 24 per cent SiO_2 and 10 per cent Al_2O_3 was found, on heating to 1500° for 20 minutes, and cooling, to consist of about two-thirds of beta $2CaO.SiO_2$ enriched with CaO taken up in solid solution, $3CaO.Al_2O_3$, $5CaO.3Al_2O_3$ and a very little free CaO. These are the compounds believed by Dyckerhoff to be present in cement clinker. Only at temperatures higher than are obtained in the cement kiln are $3CaO.SiO_2$ and $8CaO.Al_2O_3.2SiO_2$ believed to be formed. The essential hydraulic constituent is stated to be beta $2CaO.SiO_2$ enriched in CaO, which makes up about 68 per cent of the cement. The remainder of the material serves to aid the adsorption of the lime, and to hinder the inversion of the beta to the gamma $2CaO.SiO_2$.

Since Dyckerhoff believed the unstable form of the $2CaO.SiO_2$ to be the active hardening agent in portland cements, and the unstable form of $5CaO.3Al_2O_3$ to be the active hardening agent in the high-alumina cements, he suggests that, for the preparation of any reactive cement, it is only necessary to fix an unstable form of one of the constituents.

By using an actual commercial raw mixture, Dyckerhoff found that at 1285° the product contained 60 per cent $2CaO.SiO_2$, while if brought to 1800° there is present 90 per cent of the ternary compound $8CaO.Al_2O_3.2SiO_2$, or a similar compound in which some Al_2O_3 has been replaced by Fe_2O_3. Since commercial cements are burned at about 1450°, it is assumed that the constitution "will correspond to a state of equilibrium between these two points," but, by experiment at 1450°, no $3CaO.SiO_2$ or $8CaO.Al_2O_3.2SiO_2$ were found.

Janecke[61] has emphatically denied the contention of Dyckerhoff that the compound is produced only at temperatures higher than are attained in commercial kilns. He urges again that this compound is in fact the alite of portland cement, while belite may very probably be $2CaO.SiO_2$ or a solid solution of $2CaO.SiO_2$ and CaO.

Concerning the alite crystals, Janecke writes:

> It would be very remarkable if, as Dyckerhoff assumed, the strongly birefracting $2CaO.SiO_2$ $(\gamma - \delta = 0.016)$ would become weakly birefracting $(\gamma - \delta = 0.004)$ by taking up lime. This must at least be proved more conclusively. Even if this did happen, the alite should show the character of a mixed crystal (stratification), but this it never does.

Retrospect

A few writers think that the matter of constitution of clinker is solved. Thus Goebel[71] writes that, since it has been determined conclusively that alite is Janecke's compound $8CaO.Al_2O_3.2SiO_2$, it is appropriate to call it by the name "Janekeit," and "thereby give to the disputed compound, which has had only a perplexing name heretofore, another name which is plainly authorized and corresponds to the nomenclature of mineralogy."

Thus opinion is still divided, and divided in spite of the very intensive studies based on Gibbs' rule of phase equilibria which have been performed by the staff of the Geophysical Laboratory, by Dyckerhoff under the direction of Professor Nacken, and by other investigators. Each new student enters the field with the determination that his researches shall advance the solution of the century-old problem. Each contributor adds new light and aids in the inevitable progress toward complete knowledge. The laws which control the reactions are fixed. It is the reasoning of man which is fallible. Only by the accumulation of overwhelming evidence, repeatedly corroborated, is it permissible to hope for or even to desire a complete uniformity of scientific opinion.

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[70] C. Biehl, *Zement, 14* (1925), 379; *Protokoll* Veriens Deut. Portland Cement Fab., *48* (1925).

[67] Walter Dyckerhoff, Dissertation, Leipzig, 1925. *Zement, 13* (1924), 681; *14* (1925), 3, 21, 60, 103, 120, 140, 172, 200.

[61] E. Janecke, *Z. anorg. allgem. Chem., 76* (1912), 200, 357; *Protokoll* Veriens Deut. Portland Cement Fab., *36* (1913), 273, *37* (1914), 160; *Z. anorg. allgem. Chem., 93* (1915), 271; *Zement, 14* (1925), 272.

[71] H. Goebel, *Zement, 14* (1925), 538.

Reinforced Concrete Bridge Roadway
on the
Delaware River Bridge

Trusses Having Web Members Attached to Chord Bars Used as Reinforcement—Design of Floor System and Roadway Slab—Detailed Description of Reinforcement—Methods Used in Placing Concrete—Specially Designed Expansion Joints

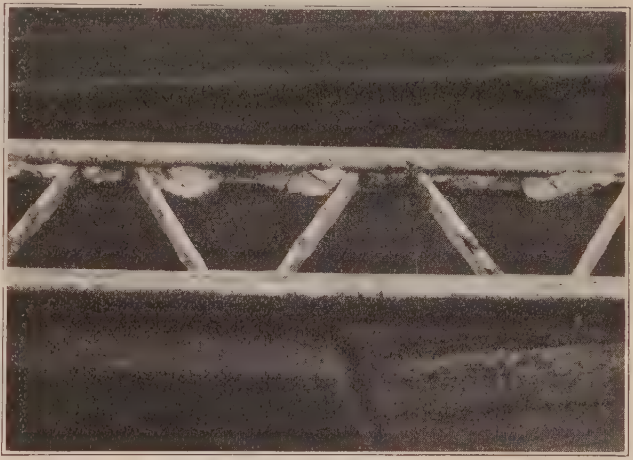
By CHARLES CARSWELL
Assistant Engineer, Delaware River Bridge Joint Commission

REINFORCEMENT in the shape of trusses having web members rigidly attached to the chord bars is a feature of the roadway slab on the recently opened Delaware River bridge connecting Philadelphia, Pa., and Camden, N. J. The trusses provide unusually rigid reinforcing with high shear resistance, combined with greater ease of placing than the ordinary system of roadway reinforcing.

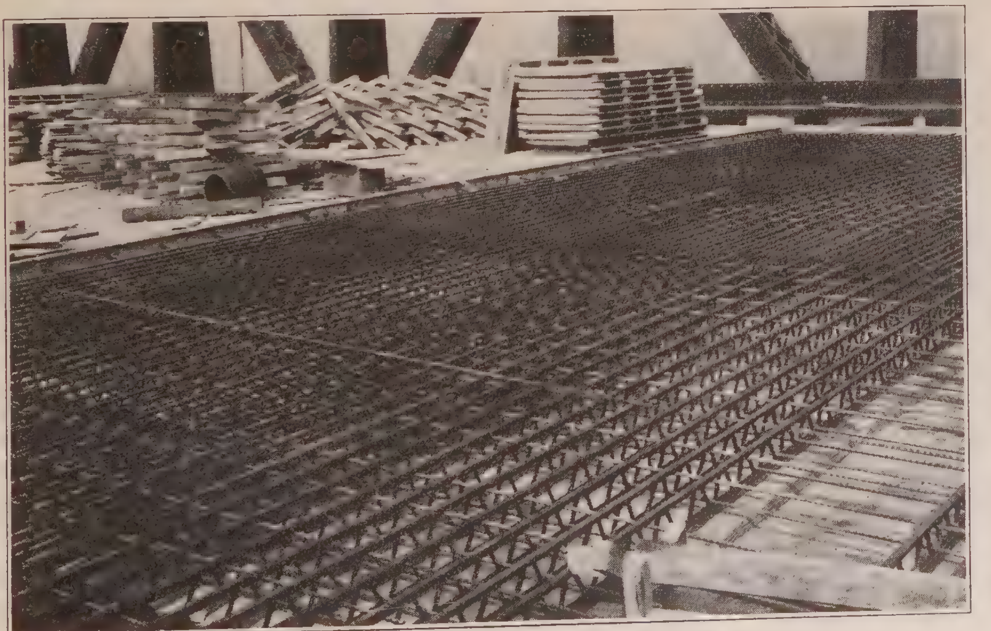
The bridge is of the suspension type with main span 1,750 feet long—the longest suspension span in the world—and two side spans of 720 feet. The suspended structure affords a clearance of 135 feet above the river. The approaches are steel viaducts with masonry piers and abutments and the total length of the bridge from end to end of approaches is 1.8 miles. The roadway is 57 feet wide between curbs and is located in the center of the deck, which provides space for two trolley lines on each side of the roadway, the total width of the structure being 128 feet 6 inches.

Floor System

The floor system of the bridge structure consists of 8-ft. steel floor beams riveted to each panel point of the stiffening trusses (20 ft. 6 in. center to center in the main span and 20 ft. 8 in. center to center in the side spans), with 18-inch I beam stringers spaced 3 ft. 10 in. center to center. Expansion joints are provided at every second floor beam to prevent the floor system participating in the



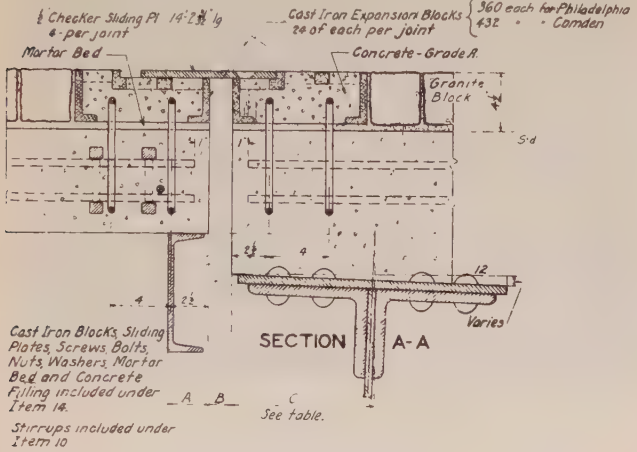
A section of a reinforcing truss removed from one of the test slabs. The bonding of the concrete in the chord channels is particularly noticeable.



Reinforcement for the roadway slab in place. Form sections are seen in the background.

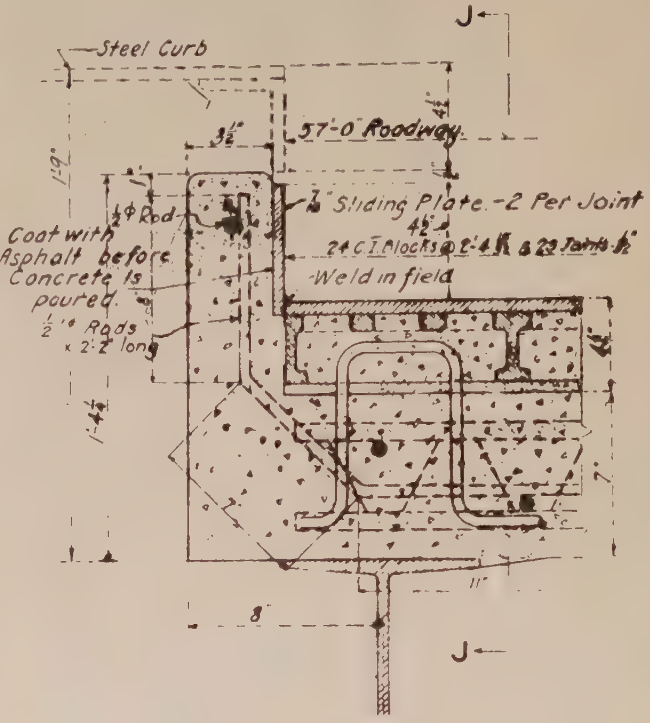
stresses set up in the stiffening trusses. The main expansion joints of the structure are at the towers and anchorages, where rocker connections are provided for the stiffening trusses. The expansion joints at these points consist of toothed gratings and permit about 12 inches of movement at each point. On the approaches the steelwork is similar to that of the main structure, with expansion joints at intervals varying from 80 to 180 feet.

A section of the approach roadway on the Philadelphia side.


⅛ Checker Sliding Pl 14'-2¾" lg
4-per joint
Cast Iron Expansion Blocks 24 of each per joint
360 each for Philadelphia
432 " " Camden
Mortar Bed
Concrete - Grade A.
Granite Block
5·d
4½"
1½
2½
4
12
4
2½
Varies
SECTION A-A
Cast Iron Blocks, Sliding Plates, Screws, Bolts, Nuts, Washers, Mortar Bed and Concrete Filling included under Item 14.
A
B
C
See table.
Stirrups included under Item 10

Detail of roadway expansion joints on the approaches.

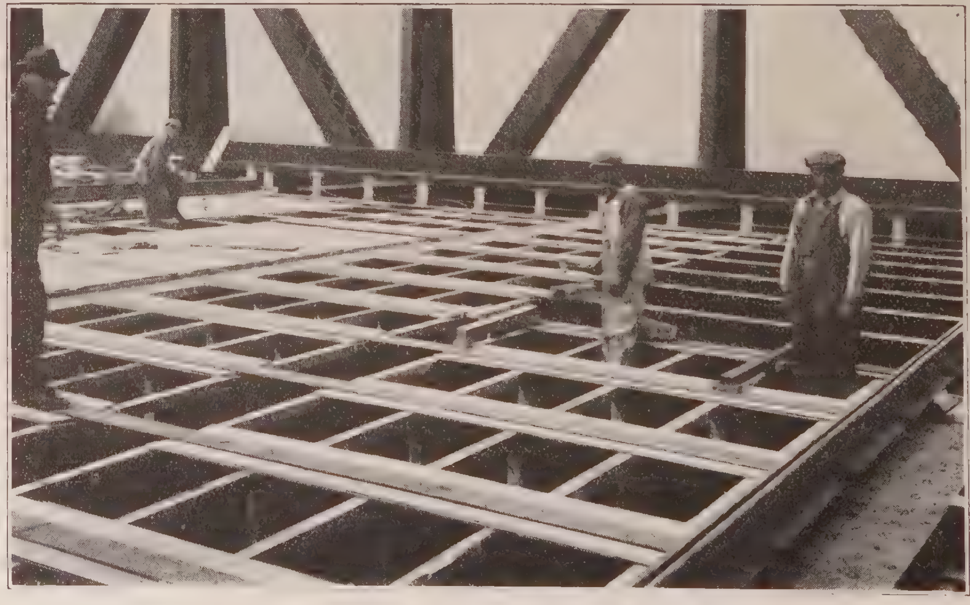
The roadway slab rests directly on the stringers. The slab is designed for a concentrated axle load of 30,000 pounds plus 50 per cent impact. On the suspended spans the slab is 6 inches thick and carries an asphalt wearing surface 2½ inches thick. On the approaches the slab is 7 inches thick and the paving is granite block 4 inches deep. The truss reinforcing was designed to permit the use of the thin slab with consequent reduction of dead load on the suspended spans.


J
Steel Curb
1'-9"
3½"
57'-0" Roadway
4½"
½ϕ Rod
⅞" Sliding Plate. -2 Per Joint
4½"
24 C.I. Blocks @ 2'-4" & 23 Joints ½"
Weld in field
Coat with Asphalt before Concrete is poured.
½"ϕ Rods × 2'-2" long
1'-4"
7"
11"
8"
J

Detail of method of constructing curbs

Reinforcement

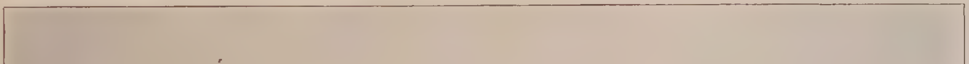
The specifications for the reinforcing trusses required them to be 4½ inches deep out to out of chords, either cut from a solid section or with web members "positively attached" to the chord bars. It was specified that the



Building the forms for the roadway slab.

attachment should develop the yield point strength of the web members (32,000 lb. per sq. in. minimum) without becoming loose. To meet these requirements, the contractor supplied trusses with "rivet-grip" connection between chords and webs. The chord bars are rolled channel sections; the web bars are flats rolled with projecting lugs on the sides. In the process of manufacture the web bars were first bent to the required shape and then assembled with the chord channels and passed through a press which forced the flanges of the channels onto the lugs of the web bars. The gripping of the web lugs by the chord flanges constitutes the "rivet-grip" connection and develops the specified strength.

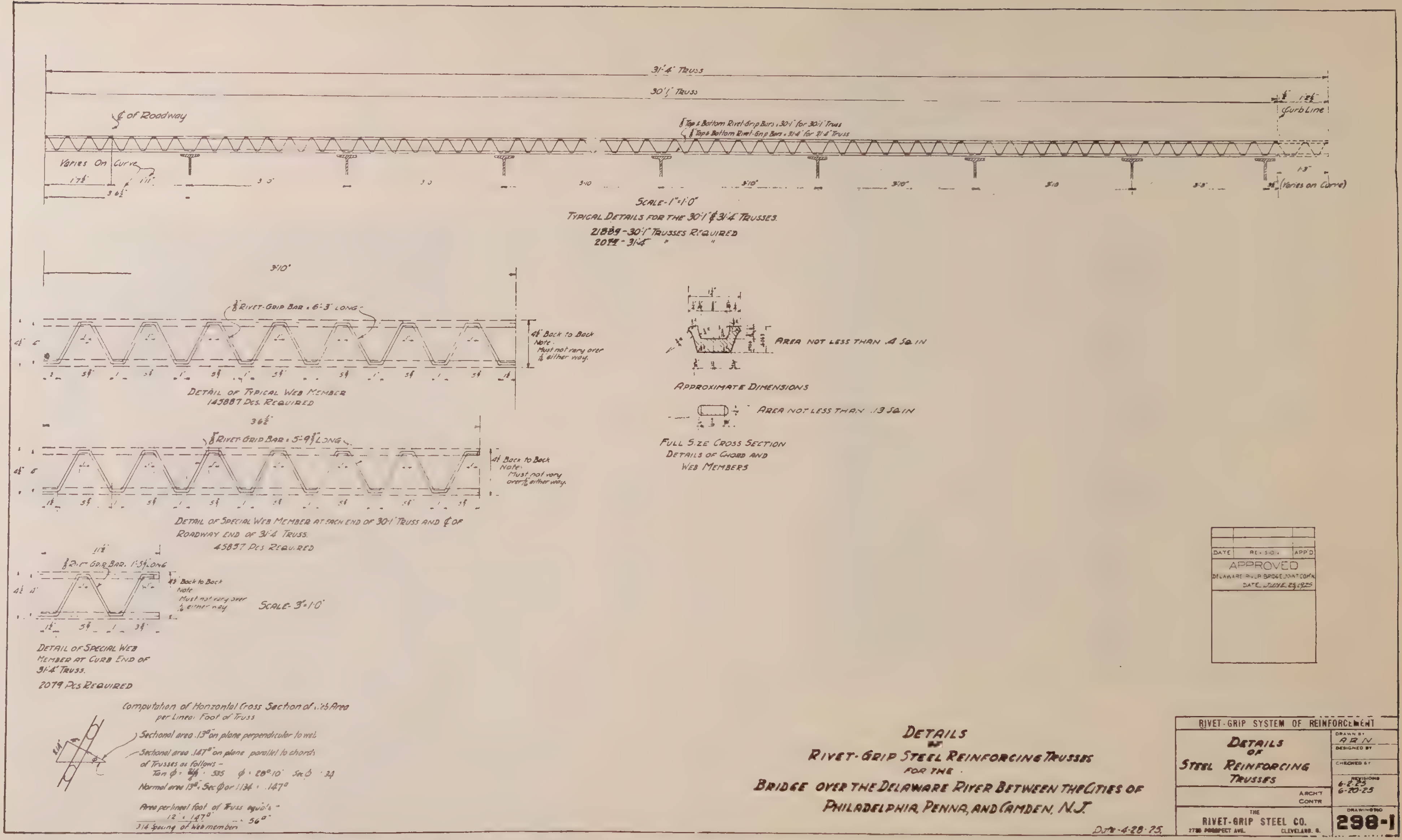
Concreting the sidewalks on the Camden approach. The concrete was elevated in the tower and distributed from this point for both the roadway and the walks.



Constructing the roadway approach on the Camden side.

A total of 725,000 linear feet of trusses were required and as this quantity represented a considerable increase over similar previous production by the contractor, the manufacturing methods were developed for this work. Previously, reinforcing trusses embodying the "rivet-grip" principle had been fabricated by the use of pneumatic hammers. Many difficulties were encountered in the development of the presses for the work, failures of the machinery occurring in several cases. The difficulties were satisfactorily overcome by the contractor, however, and the entire 725,000 feet produced and delivered to the bridge within six months from the date the contract was executed (97 per cent of the production was accomplished in the final 11 weeks).

The reinforcing trusses are spaced 6 inches center to


31'-4" Truss
30'-1" Truss
℄ of Roadway
Curb Line
⅝ Top & Bottom Rivet-Grip Bars, 30'-1" for 30'-1" Truss
⅝ Top & Bottom Rivet-Grip Bars, 31'-4" for 31'-4" Truss
Varies On Curve
(Varies on Curve)
Scale-1"=1'-0"
Typical Details for the 30'-1" & 31'-4" Trusses.
21889-30'-1" Trusses Required
2079-31'-4" " "
⅜ Rivet-Grip Bar, 6'-3" Long
4½" Back to Back
Note:
Must not vary over ⅛ either way.
Detail of Typical Web Member
143887 Pcs. Required
⅜ Rivet-Grip Bar, 5'-9⅜" Long
Detail of Special Web Member at each end of 30'-1" Truss and ℄ of Roadway End of 31'-4" Truss.
45857 Pcs Required
⅜ Rivet-Grip Bar, 1'-5⅜" Long
Scale-3"=1'-0"
Detail of Special Web Member at Curb End of 31'-4" Truss.
2079 Pcs Required
Area not less than .4 Sq.In
Approximate Dimensions
Area not less than .13 Sq.In
Full Size Cross Section Details of Chord and Web Members
Computation of Horizontal Cross Section of Web Area per Lineal Foot of Truss
Sectional area .13☐" on plane perpendicular to web
Sectional area .147☐" on plane parallel to chords of Trusses as follows –
Tan φ = 4½/8 = .535 φ = 28°10' Sec φ = 1.134
Normal area .13☐" Sec φ or 1.134 = .147☐"
Area per lineal foot of Truss equals – 12 × .147☐" / 3⅛ Spacing of Web members = .56☐"
Date Revision App'd
APPROVED
Delaware River Bridge Joint Comm.
Date June 29, 1925
Details
of
Rivet-Grip Steel Reinforcing Trusses
for the
Bridge over the Delaware River between the Cities of Philadelphia, Penna. and Camden, N.J.
Date 4-28-25
RIVET-GRIP SYSTEM OF REINFORCEMENT
Details of Steel Reinforcing Trusses
Drawn by A.R.N.
Designed by
Checked by
Revisions 6-2-25 6-20-25
Arch't
Contr
The Rivet-Grip Steel Co.
2750 Prospect Ave. Cleveland, O.
Drawing No. 298-1

The roadway slab rests directly on the stringers. The slab is designed for a concentrated axle load of 30,000 pounds plus 50 per cent impact. Reinforcing trusses with web members positively attached to the chord bars were required. A total of 725,000 linear feet of trusses were required.

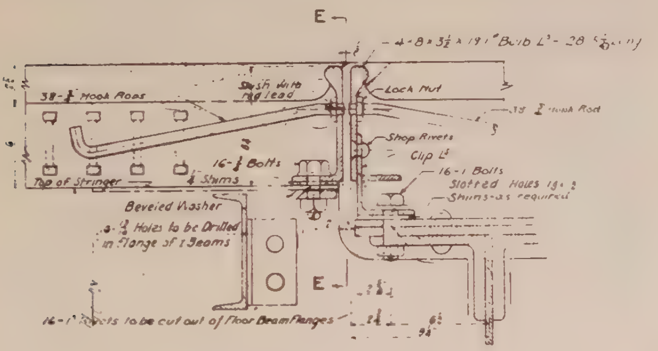
center on the suspended spans and 7 inches center to center on the approaches and were held in position during placing of the concrete by special steel chairs resting on the stringers, which kept the trusses at the proper elevation above the forms and maintained exact spacing between the trusses. Longitudinal bars ½ inch in diameter completed the reinforcing system and assisted in holding the trusses rigidly in position.

Placing Concrete

Wooden forms designed for ease and safety of construction and removal were developed by the slab contractor for the work. They were removed by use of a scaffold one panel long and the complete width of the roadway and were re-used several times.

The concrete for the 6-inch slab was specified to have a strength of 2,500 pounds per sq. in. (nominal proportions 1:1½:3) and for the 7-inch slab to have a strength of 2,000 pounds per sq. in. (nominal proportions 1:2:4). The average strengths of test cylinders made in the field was 2,700 and 2,200 pounds per sq. in. respectively. Concrete was mixed in three central mixing plants located strategically along the work, beneath the bridge. It was elevated to the bridge deck, and then distributed along the structure by one-yard dump body Ford trucks, operated on a plank roadway until the slab was completed. On the suspended structure the weight of the slab was used as surcharge to assist in closing the connections of the stiffening trusses for riveting and the order of concreting was adjusted to these requirements. The maximum rate of concreting was five double panels (about 200 feet) in one day.

In order to insure a smooth surface on the bottom of the slab, the concrete was mixed moderately wet and after it was placed the forms and reinforcing were vibrated by rubber shod pneumatic hammers. Excellent results were secured by these means.



Detail of stress expansion joints on the suspended spans.

Expansion Joints

The main expansion joints are at the towers and anchorages and consist of machined steel castings which interlock in tongue-and-groove fashion. Grooves are machined in the top surfaces to provide foothold for horses and tractive resistance. The so-called "stress expansion" joints on the suspended structure are formed with 8 by 3½ inch bulb angles that dam the concrete on each side of the joint. The bulb angles are fastened securely to the stringers on one side of the joint and the floor beams on the other side, and are bonded into the slab by hook bolts. The nominal distance between the backs of the bulb angles is ½ inch.

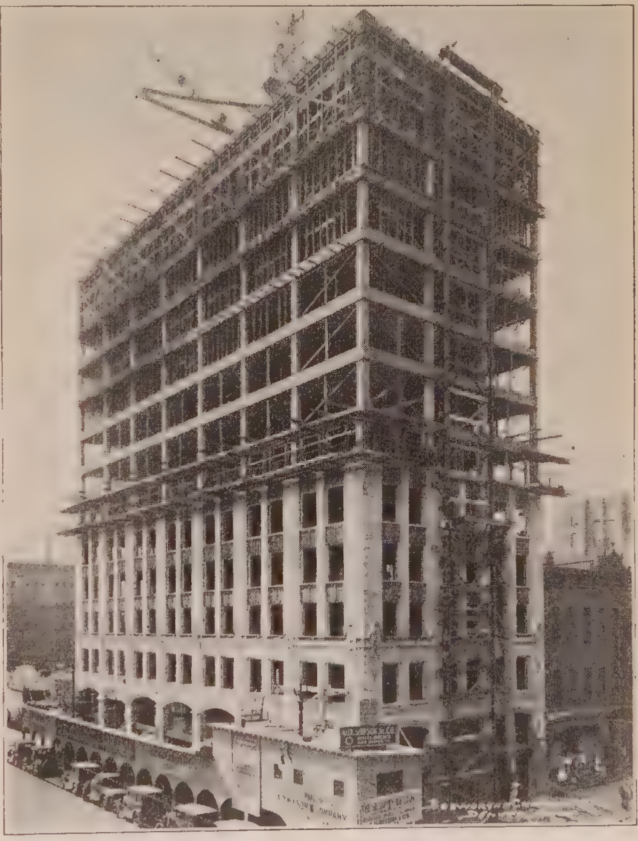
The expansion joints on the approaches consist of a sliding plate resting on cast-iron blocks. The iron blocks are carefully machined, with a recess for the plate. They are anchored in place on top of the reinforced concrete slab by special stirrups set in the slab. A ½-inch checkered plate is attached by tap screws to the castings on the up-grade side and slides upon the surface of the other castings. The nominal opening at the joints is from ½ to 1½ inches for different sections of the approaches. These joints have proved quite satisfactory and eliminate the bump usually experienced in riding over a sliding plate type of expansion joint.

As protection against traffic accidents on the bridge, a heavy structural steel curb is provided at each side of the roadway and outside this curb is a steel pipe railing extending 3 feet above the roadway.

The bridge was built as a joint enterprise of the state of New Jersey, the state of Pennsylvania and the city of Philadelphia. Its construction was under direction of a board of engineers headed by Ralph Modjeski, chairman and chief engineer, with George S. Webster and Laurence A. Ball as associates. The reinforcing trusses were supplied by the Rivet Grip Steel Co., Cleveland, Ohio. The slabs were constructed by Francis J. Boas, Philadelphia.

Good Time Made on Concrete Job in Denver

The accompanying photograph shows the Security Building in Denver, Colo., being built for the Bosworth-Chanute Company of that city. This twelve-story reinforced concrete structure was brought to the stage of completion shown by the photograph by August 17. In 7½ weeks time the contractors were able to erect ten stories of the skeleton and do the masonry work on five stories. One day shift only was used, working six days a week during that period. This certainly demonstrates the rapidity with which reinforced concrete work may be carried on by the experienced builder. W. E. and A. A. Fisher of Denver were the architects, the Alex. Simpson, Jr. Co. of Denver were the general contractors, and Walter H. Wheeler of Minneapolis, structural engineer, designed the concrete work on the structure. This structure was designed according to the spiral mushroom system.



Measurements Being Made on Experimental Dam

Engineering Foundation of New York Making Tests on Stevenson Creek Experimental Dam Near Fresno, Calif.

In one of the steep, rocky canyons of the high Sierras near Fresno, California, an arch dam sixty feet high, of portland cement concrete, has been built wholly for experimental purposes by a committee of the Engineering Foundation of New York, composed of members of the American Society of Civil Engineers.

Many tests have been made and valuable information is being obtained, but the tests are not yet complete. Months of work are still ahead to learn all the lessons which the Committee on Arch Dam Investigation hopes to get from this experiment.

Building and testing this dam to a height of sixty feet is costing $110,000. It did not break even when the reservoir was filled so full of water that some of it flowed over the top of the dam. To cause the dam to break under pressure of water in the reservoir back of it may necessitate building the dam up ten, twenty, thirty, or possibly forty feet higher, or to a total height of one hundred feet, at a further expense of some $30,000.

Early in April, after months of work, excavation in the granite sides and bottom of the gorge for the foundation of the dam across Stevenson Creek was completed. April 19 the first concrete was placed in the wooden forms and on June 4 the last concrete had been laid to build the dam to a height of sixty feet.

The reservoir back of the dam can be filled not only from the water of the creek, which at times almost dries up, but from one of the great water supply tunnels of the hydro-electric plants of the Southern California Edison Company, which pierce the mountain just above this reservoir.

Consequently, the engineers are able to fill and empty the reservoir back of the experimental dam in a short time, just as one fills and empties a hand basin through the faucets and the waste pipe. This permits experiments to be made at will under conditions of full control, very much as if this huge "specimen" were in a laboratory.

First Experiments

Various measurements and other observations were begun with the first steps of construction. Water was first let into the reservoir for test purposes, to a depth of ten feet, on July 1. Successively, tests have been made with water twenty feet deep against the dam, then thirty feet, forty feet, fifty feet, and finally, sixty feet, level with the top, on September 18.

In all, thirteen of these "load" tests have been made to date. With the water at each level full series of measurements were carried out. Then the reservoir was emptied and other series of measurements taken with no water against the dam. These tests were made at night, for then the temperature changes would be least during the hours required for making and recording the many hundreds of measurements.

When the reservoir was filled to the sixty-foot level for the first time, on September 18, several members of the committee, a number of engineer representatives of contributors and a few guests were present, beside the test staff. At noon there was some fifty feet of water behind the dam and the water was rising slowly.

Full depth was attained about four o'clock, and the water was allowed just to overflow the crest of the dam. Then the water surface was held even with the top of the dam until eleven o'clock p. m. (when the measurements were begun) and throughout the series of measurements. Then the reservoir was emptied and the usual "no-load" measurements were made. Many guests witnessed the midnight measurements. All were enthusiastic about the conditions for the tests.

The testing staff is now working up the notes preparatory to a preliminary report and plans for the next stage of experiment. Consequently, it would be premature to attempt a specific statement of results at this time.

Some of the measurements appear to differ from expectations based on prior practice and theory. Mature consideration must be given not only to the immediate results of tests on the experimental dam, but also to special tests of concrete and instruments made in laboratories of the University of California, California Institute of Technology, Bureau of Standards and the Portland Cement Association, observations on dams in service and much other information from many sources.

From the tests thousands of records have been and are being made. They are being studied, tabulated and graphed by the testing staff so that the facts gathered may be reduced to form for interpretation by the committee and its advisers.

Even before construction of the Stevenson Creek Dam was begun, there were preliminary tests of concrete materials and concrete. As construction progressed, various control tests of the concrete being used were made at the camp.

But much more was needed. Therefore, an extended program of very precise tests of the physical characteristics of concrete have been undertaken by the Engineering Department of the University of California, aided by a substantial contribution of funds from the Portland Cement Association.

Results of these tests in themselves are expected to be a valuable addition to engineering knowledge. Toward the end of 1926 the subscriptions for the Stevenson Creek experiment totaled nearly $105,000.

To complete the experiment, the committee now seeks funds to raise the dam until it breaks under water pressure. If it should be necessary to increase the height to one hundred feet, the cost for construction and tests would be about $30,000.

Subdivider Pays Tribute to Concrete

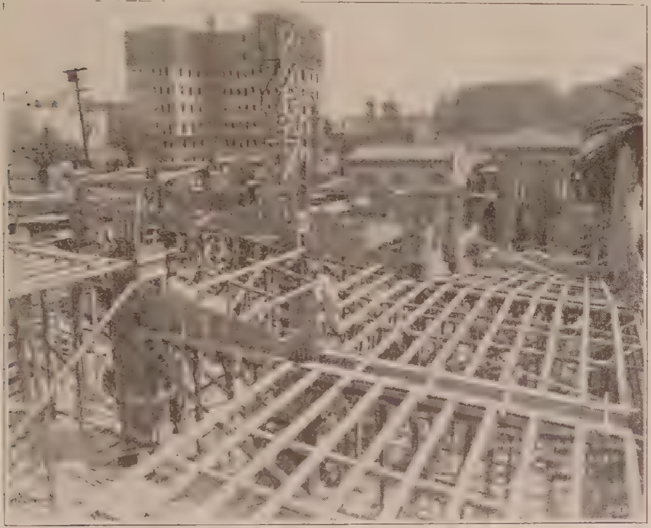
When the question, "What material do you consider best in paving any subdivision?" was put to William Zeloskey, Chicago subdivider and builder of more than 30 years' experience, during a lecture delivered by Mr. Zeloskey before the Cook County Real Estate Board in Chicago recently, he replied: "Concrete is obviously the best; I have found it more uniformly satisfactory, more durable and most economical in subdivision development."

An Eight Story Concrete Garage

Description of Design of a Structural Concrete Garage in Los Angeles—Method of Treating Floors

This unusual garage building which has just been completed in Los Angeles was designed by Fisher, Lake & Traver, architects and engineers, and built by the Trewhitt-Shields Company, managers of construction. The building is a reinforced concrete frame with 8-in. double reinforced concrete filler walls. The building is 100x120 ft., 8 stories, with four stores and the garage and accessory room and service on the first floor.

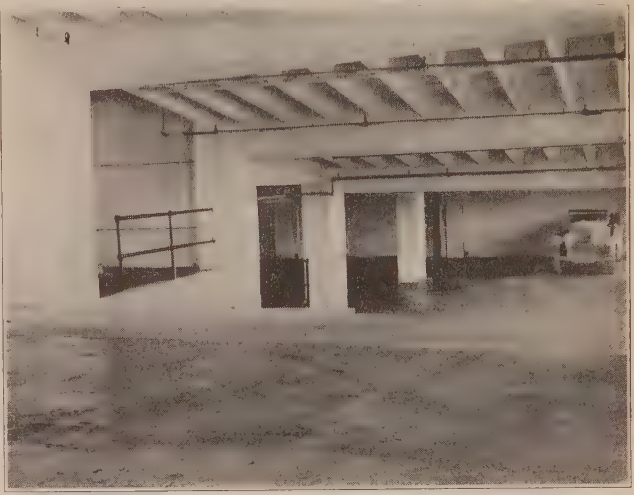
Each of the upper floors is split into two levels—the levels being one-half story apart. Concrete ramps lead from each half floor to the half floor above it. The De-Humey Patented System of Ramps was used. The ramps are at each end of the building with driveway between them. One can drive in at the entrance on the first floor and drive the car to any floor in the building or up onto the roof where a magnificent view of the city is to be had. The grade of the ramps is about 14 per cent. On each side of the driveways between the ramps are stalls for cars. The garage has room for about 500 cars.



The form work for the first floors showing arrangement of floor levels

The roof is designed for the same live load as all of the floors. It will be used for day storage for cars.

The building is equipped with a complete system of automatic sprinklers for fire protection, with two 10,000-gallon pressure tanks on the roof, in accordance with the requirements of the National Board of Fire Underwriters. There is also a vacuum system for cleaning cars on each floor. On each floor is a telephone. Stairs and elevators going from the first floor to the roof are provided for pedestrians.



Showing the arrangement of the ramps

Floor finish throughout was placed monolithic with base and the dry topping method was used. This method con-

Just before and after the completion of the monolithic concrete 8-story garage. Each floor is split into two levels, the levels being half a story apart as shown by the elevator windows on the right hand wall sists of mixing the sand and cement in the proportions desired and spreading the same over the surface of the rough concrete slab immediately after pouring of the concrete base. The dry material is then screeded out and floated, the dry material drawing up the excess moisture from the slab below. The surface is then troweled to a smooth hard surface. The topping now becomes an integral part of the base and prevents any possibility of the top finish cleaving from the base due to the difference in expansion of the base and top finish and also due to abrasion breaking the bond between the base and top.

The forms were left on the walls about four days and on the slabs, beams and girders about fourteen days before stripping.

This model garage is in a strategic location with the new Elks Club costing over $2,500,000 only a few steps away and surrounded as it is by high class apartment houses. The building has the appearance of being an apartment house with stores underneath. There is no suggestion of its being a garage.

Concrete Ash Containers Give Tidy Lawns

Almost every city and suburban home should have a small, concrete ash container set at the edge of the house where the ashes can be dumped from furnace or stove as soon as they are carried out. So many otherwise attractive lawns are disfigured because of unsightly piles of ashes and cinders, yet the owners have no other place for them. If the ashes are piled up in one corner of the basement until spring arrives, the dust from this accumulation settles on everything within reach.

This idea is not mere theory but is based on actual ash containers, two of which are shown in the accompanying illustrations and which were made and are now in use in Wahoo, Nebraska. Wahoo is the county seat of Saunders County and is one of the most prosperous and attractive towns in the state. Favorable comment regarding the neat appearance of the lawns in the edge of town are common and the ash containers which are used in a large number of cases are perhaps as much directly responsible as any single item.

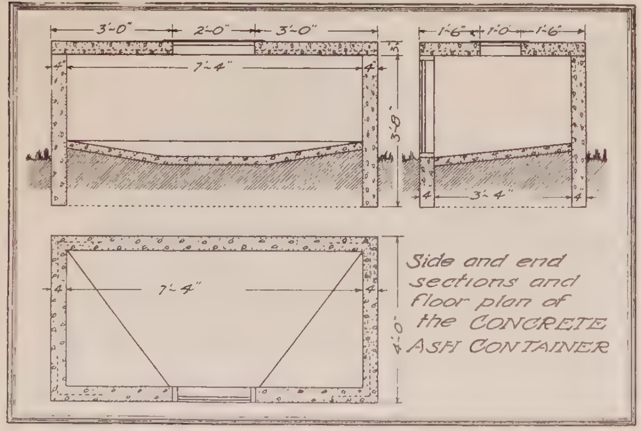

3'-0"
2'-0"
3'-0"
1'-6"
1'-0"
1'-6"
3"
4"
7'-4"
4"
3'-8"
4
3'-4"
4
4
7'-4"
4
4'-0"
Side and end sections and floor plan of the CONCRETE ASH CONTAINER

Figure 1

To give an idea of how these containers are made, we have included a floor plan and two sections of the ash container shown in Fig. 1. This sets at the side of the concrete garage drive and has a door in the top and also one in the side. The door through the roof is used for dumping the ashes in, while the side door is opened when the ashes are to be removed.

This particular ash container is eight feet long, about four feet high overall with the walls extending fully one foot below ground, and the walls are four inches thick. The roof is of reinforced concrete, a single slab, three inches thick and poured in place with boards nailed over the inside form at the top for supports. The upper door is two feet long and one foot wide. The cover consists of a sheet of heavy iron with cleats of wood underneath to hold it in place. Two rings held with staples offer an easy way for lifting it off.

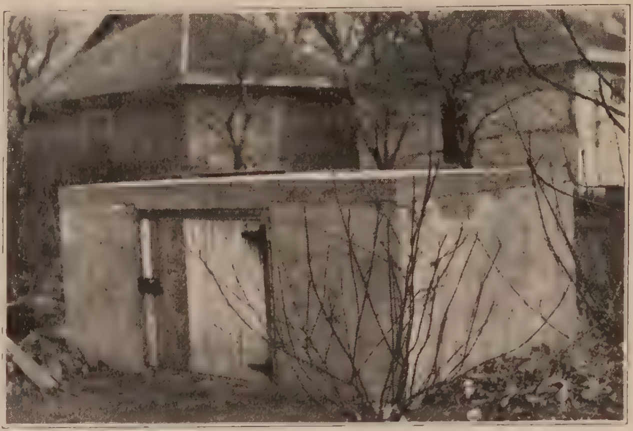


Figure 2

The floor inside slopes from three directions toward the side door in front. This floor is also of concrete and about two inches thick, and was poured in place after the outside structure had been erected. The front door has a casing of two by four inch piecing which were set into the forms before the concrete was poured and has a tight fitting door as indicated.

In Figure 2 we show a detailed corner of one new residence in Wahoo and while the owner in this case did not care for a garage, the ribbon driveway of concrete leads to the ash container so that in the spring the truck hired for the ash removal will not mutilate the lawn. There is no reason why an ash container and garage could not set side-by-side with a concrete floor of ample size and breadth in front so that the same drive could be used for hauling off ashes and for reaching the garage. In Figure 2 may be seen the coal door near the corner of the house which is within easy reach of the drive. This particular ash container is of concrete blocks but has a single slab of concrete for the roof, and there is an iron door in front.

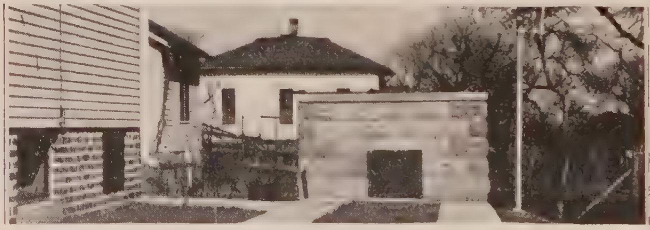


Figure 3

An ash container of this type is possibly one of the best investments that the home owner in small or large cities or towns can make. The cost in most cases should not exceed twenty-five or thirty dollars and if the work is done in spare time, which is the ideal way, the cost will be even less. Dimensions will vary of course according to the amount of coal consumed each winter and whether the container is to be used for some other purpose. If you wish, you can add two feet to the length of this ash container and provide a grate in one partitioned end, set a flue up through the top and provide a door in front for all garbage and refuse to be burned when desired. This addition to the idea would cost only a few dollars more but would then serve a double purpose.

Cast vs. Drilled Specimens of Concrete

Some Interesting Experiments to Determine the Relation Between Laboratory Concrete and Concrete Drilled from the Finished Structure

By G. W. HUTCHINSON
Chief, Concrete Engineering and Inspection Bureau, Lake Worth, Florida

THE growing tendency to specify concrete strength in addition to the quality of the constituent materials, consistency, etc., raises the question as to what extent research has been carried on to determine the practicability, as well as the economy, of such specifications. The question will also lead to a consideration of the economy of judging the strength of concrete in the completed structure by the results of tests made from the freshly mixed concrete at an arbitrary age.

Among the investigations carried on by the writer while connected with the North Carolina State Highway Commission, one especially brings out the effect of variables encountered in placing field concrete, and the lack of relation between specimens drilled from the latter and those cast in the laboratory or field.

Tests Made

The investigation referred to consisted of cast as well as drilled specimens from the field concrete, and cast specimens made in the laboratory. Tests of the laboratory specimens were made both at the age of 28 days and 3½ months, the field cast specimens at 28 days, and the drilled cores at 3½ months.

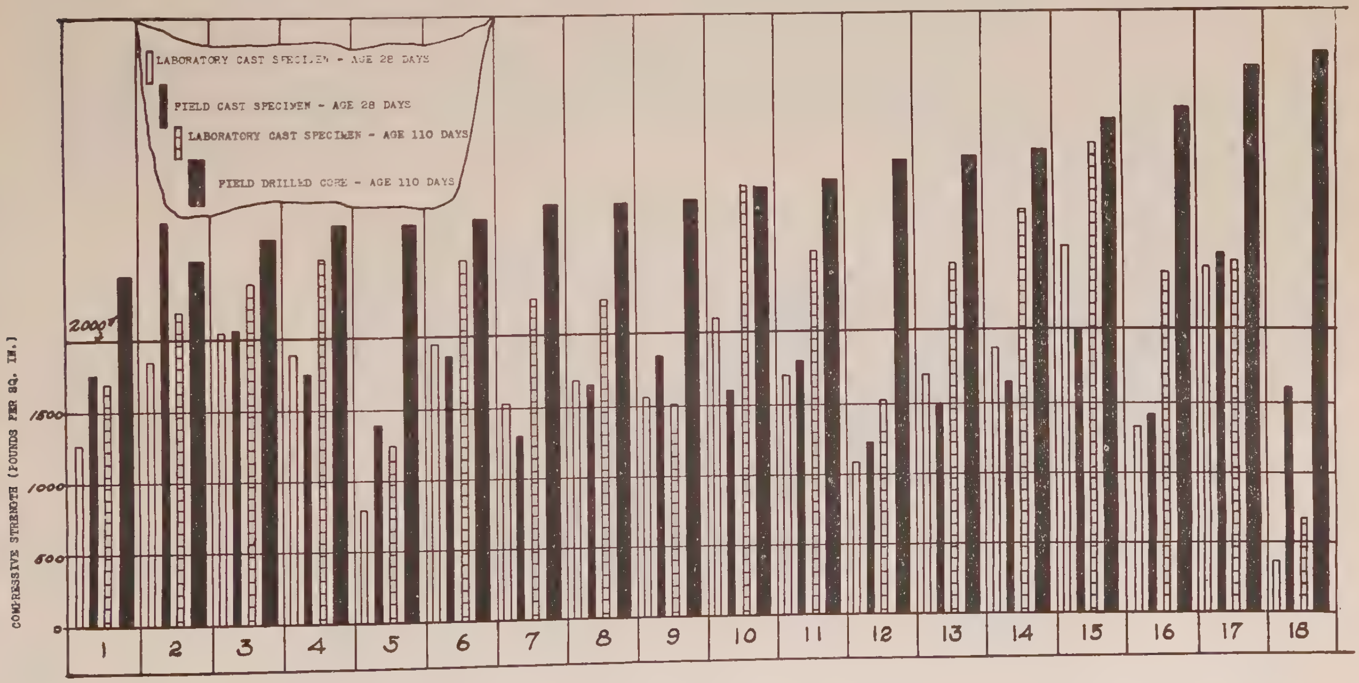
Only such projects as used the average 1:2:4 mixture are given here as examples. Eighteen projects of this type were investigated. The investigation included projects on which there were variations in aggregates, cement and other conditions. All materials had been tested and passed the standard requirements.

All tests were made by the same experienced laboratory operator. The operator selected a given batch of dry materials at the mixer on each project. A sufficient quantity of the dry materials from this batch was shipped to the laboratory for 10 laboratory specimens. The rest of the materials went through the mixer and the resulting mixed concrete was spread evenly across the entire width of the road. As soon as it was placed in this manner, field specimens were cast. Stakes were driven at right angles to the center line of the pavement so that a line between one on each side would mark the center of the portion of the pavement formed by each given batch.

Laboratory Tests

Five field cast specimens were cured beside the road for 21 days and then packed in damp sand and shipped to the laboratory for test at the age of 28 days. Four cores were drilled from each batch and were tested at the age of 3½ months. All the laboratory specimens were made on 3 successive days. Five of these were tested at the age of 28 days for comparison with the field cast specimen, and five at the age of the field drilled cores. On each day's mixing, 5 specimens of a laboratory standard concrete were made for reference. Especial care was given to the capping of all specimens. The ends of each specimen were ground to a plane surface by means of a revolving grinding disk. Standard laboratory and field practice was followed throughout the investigation.

The results of the tests are given in Table 1 and Figure 1. The field cast specimens (6x8 in.) and the drilled cores



(6½ in. diameter) were corrected in strength to conform to that of an equivalent standard 6 x 12-in. cylinder.

From the results, it is possible to form several conclusions, none of which, however, appear to be consistent with economy in specifying a given strength at an early age at least. The tests had the advantage of as uniform control as possible under practical conditions, and probably more so than would be accorded individual field projects not able to carry sufficient equipment and a trained laboratory force to reduce the personal equation, etc., to the minimum. These factors themselves have considerable effect on strength tests of concrete.

Results of Tests

The standard laboratory concrete used for reference was consistent in showing (average of five specimens) an average strength at 3½ months of 126, 132 and 136 per cent of the 28-day strength. This represented an average increase of 131 per cent strength for the 3 days' mixing and less than 5 per cent variation from the average for the individual days. The laboratory specimens made from the 18 given combinations of cement and aggregate from the field, and tested at the 3½-month period varied from 97 to 182 per cent of the 28-day strength under the same conditions. All specimens were made and stored under identical conditions.

The drilled cores averaged about 40 per cent higher in strength than the laboratory cast specimens at the same age (3½ months).

The average strength of the drilled cores from a given project ranged from a minimum of about equal strength to over 100 per cent higher than the laboratory-cast specimen of the same age. In one extreme case it was over 6 times higher in strength. This extreme case occurred where a fine aggregate was used with a high organic content, as judged by the colorimetric test, though making satisfactory concrete when tested previously at the source by standard methods.

It was the intent of this investigation to determine, if possible, the relation between laboratory concrete and that drilled from the finished structure. It is evident from the results secured that so much allowance must be made for the variables encountered, that no reasonable comparison can be made by which a specification for field strength, as determined by cast cylinders, could be economically enforced.

The data given are the average of either 4 or 5 specimens and are much more favorable to such a relation than by methods where but one cylinder is made from the usual representative quantity of concrete.

Conclusions

An article of considerably greater length could be written to bring out other factors to be considered in a specification of this kind. In summary, however, there does not appear to be any definite means of controlling the action of a small quantity of concrete, such as a field cast cylinder, in a way which will make the result comparable to that of the mass in place. It should lead one to consider seriously before requiring a specification for all the individual materials, the consistency and methods of placement when mixed, the curing, all other details affecting the quality of the resultant mass, and at the same time hold the contractor responsible for the quality of the finished product. Such a specification, which does not appear to be consistent with the finished product, hardly justifies itself.

Concrete structures are expensive. When failures occur they become more so. It is felt that proper recognition and a better understanding should be accorded the raw materials in general concrete practice. With this part accomplished, it would be possible to standardize field practice by assorting the aggregate into several sizes and to proportion each size, as well as the cement and water, in relation to the volume of finished concrete. By greater attention to the proportioning of the cement, aggregate, and water, in the field and a decrease in manipulation of the wet mixture, the main causes of the present non-uniform field concrete will be reduced. The average strength will be higher than that obtained in the laboratory. The cause of the greater number of failures, or the extreme variation from the average will be removed.

The normal tendency of field concrete is to increase in average strength with age. The least tendency is for it to increase in uniformity. Uniformity is a property that must be secured during the proportioning, mixing, and placing. There is little hope for correction once the mass has hardened.

Chart showing the effect of variables encountered on 18 investigations of the compressive strength of 1:2:4 concrete when tested by means of laboratory cast cylinders, field cast cylinders and cores drilled from the finished structure. All specimens in each set were made from a given batch of materials. Each result is the average of 4 or 5 specimens.

TABLE NO. 1

Project Number	**1**	**2**	**3**	**4**	**5**	**6**
412	1779	1291	1781	2244	1717	2479
577	1692	1871	2856	2315	2209	2586
535	1779	2071	2080	2244	2419	2731
588	1692	1909	1762	2315	2587	2822
765	1692	800	1400	2315	1255	2831
428	1692	1977	1893	2315	2572	2859
670	1779	1548	1310	2244	2289	2954
484	1799	1696	1665	2421	2275	2958
473	1779	1572	1872	2244	1516	2996
463	1799	2132	1606	2421	3071	3063
614	1779	1707	1815	2244	2607	3129
629	1799	1098	1238	2421	1537	3265
742	1799	1711	1491	2421	2509	3297
528	1779	1907	1662	2244	2900	3333
429	1692	2643	2044	2315	3382	3557
785	1799	1327	1408	2421	2441	3623
741	1799	2481	2574	2421	2520	3927
790	1799	370	1610	2421	662	4018

NOTE:

Column 1. Laboratory standard concrete—28 days—average five specimens.

Column 2. Laboratory concrete from the materials sent from field to laboratory. Made and cured under laboratory conditions identical with those of Column 1. Age 28 days—average five specimens.

Column 3. Field concrete. Specimens cast from concrete deposited in roadway, cured under field conditions for 21 days and then packed in damp sand and shipped to laboratory for test at 28 days. Average five specimens.

Column 4. Same as Column 1, only test age 3½ months.

Column 5. Same as Column 2, only test age 3½ months.

Column 6. Field drilled core—age 3½ months.

All laboratory specimens made to conform as nearly as possible to the consistency of that used in field.

All specimens corrected to strength of 6 x 12 in. cylinder.*

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*Correction Data for Comparative Test Results from Field Specimens, by G. W. Hutchinson, Proc., Am. Concrete Inst., v. 19, p. 191, 1923.

Dr. Duff A. Abrams made a most interesting address before the National Sand and Gravel Association as a speaker at the convention held January 17, 18, 19, in Cleveland.

While this was the eleventh of such meetings, it was the first to be accompanied by an exposition of sand and gravel machinery and equipment.

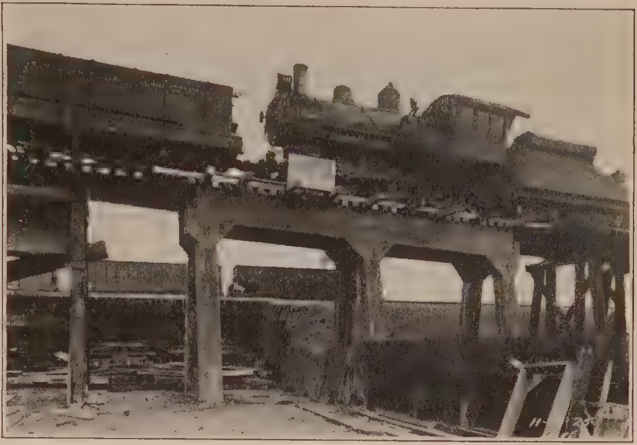
Railroads Use Quick Hardening Cement for Winter Rush Work

Rapid Hardening and Hydration of High Alumina Cements Produces Heat and Reaches Point in Curing Rapidly Where Danger from Frost Is Overcome

DURING the past few winters many railroad engineers have taken advantage of the unusual properties of Lumnite when the need developed for concrete of high early strength. Much of this work has been done in winter with very little trouble and extremely favorable results.

Several examples of work done by railroads are illustrated. Most of these jobs were done in extremely cold weather and even at temperatures of zero or below, protection was needed only for the first 24 hours. These jobs, built one day, were thrown into the service overnight and carried the heavy loads successfully.

High alumina cement possesses two important properties that give it special advantages in winter work. First, the rapid hydration or early hardening brings the concrete in a few hours to a point in its curing beyond the danger of frost attack. Secondly, this rapid hardening, a chemical reaction, produces a very considerable heat.



This concrete trestle in the D. L. & W. coal yard at Buffalo, was put in full service five days after concrete was poured.

Twelve-inch concrete slabs, placed by the W. A. Kelso Co. across tracks used by the Santa Fe & Southern Railway Co., were opened to traffic in 16 hours

A concrete bridge slab was placed during very cold weather. It was protected only for the first night. The job was done by the D. L. & W. R. R. near Buffalo, N. Y.

On one job, when the temperature of the air was 27 degrees below freezing, thermometers inserted in the concrete showed that the temperature of the concrete was 16 degrees above freezing, making it unnecessary to take the usual precautions.

The N. Y. N. H. & H. R. R. built the walls and pier for this turn-table in cold weather and allowed locomotives to use it three days after the concrete was placed

Apparently there has been some confusion as to the difference between quick hardening and quick setting. High alumina cements are not "quick setting" in the sense the term is usually used. There is ample time for mixing, placing and finishing, but after it is in place, the concrete hardens rapidly so that the strength at three days equals the strength of standard portland cements at 28 days.

1926 Construction Exceeds All Former Records

Washington, D. C.—Construction operations in the United States set a new record in 1926. The volume of these operations during the year just concluded was 2 per cent greater than the similar figure registered for 1925, when all previous records were broken, according to statistics made public by the Associated General Contractors of America.

Expenditure of $7,500,000,000 is estimated to have been involved in construction operations last year. Of this total, $5,500,000,000 was spent for construction of dwellings, office buildings and other commercial and industrial structures. The expenditure for highway construction and maintenance is estimated to have been in excess of $1,000,000,000, with a similar amount involved in construction of public works and the building operations of public utilities.

The volume of construction work carried on during December was the greatest ever recorded for that month of the year. This unprecedented December activity was in keeping with the present tendency toward increased "cold weather" operations. Although a sharp decline from the November figure was shown that month, the volume indicated for the last 31 days of 1926 was 4 per cent greater than the volume registered for December, 1925.

The December volume reached the 162 level on a scale which places the 1913 average at 100 as its basis. The average of the December volumes registered during the preceding five years is indexed at 137. This shows that the volume of construction last month was 25 points above the average for that month during half a decade and indicates the degree in which low temperatures are being defied by construction operations this season.

Proposed Concrete Warehouse for New York

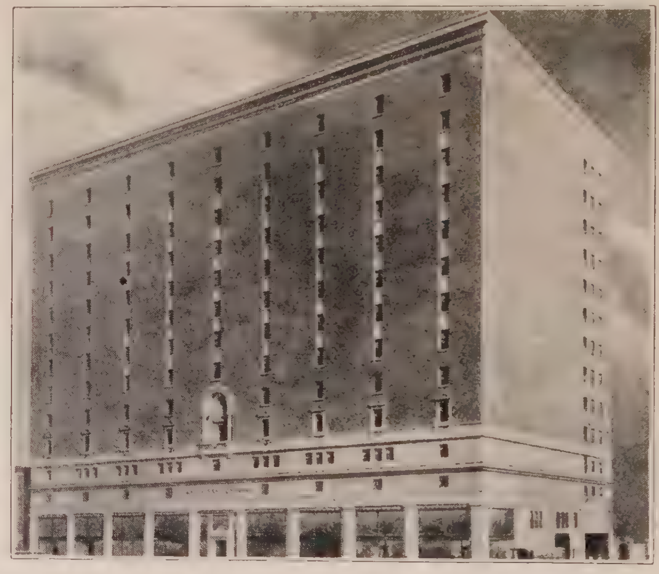
Plans have been filed by George S. Kingsley, architect, of New York City for the construction of a new 14-story building for the Lincoln storage warehouse, and the architect's drawing of the proposed structure is shown herewith.

While New York City has a great many reinforced concrete buildings very few of them are over 12 stories in height, so that the new Lincoln storage warehouse will be an outstanding example of this type of construction in the metropolitan area.

The building will be located on Third avenue, occupying the entire street front between Sixty-ninth and Seventieth streets and extending 100 feet on each of the side streets. While officially classified as a 14-story building, there will be 14 stories above grade with a mezzanine and basement, providing a total floor area of 311,000 square feet.

While complete details of the structural design are not yet available it is known that the building will be of flat slab construction with structural steel column cores up to the tenth floor. The floor finish will be placed monolithic with the structural slab.

The spandrel walls on the east or rear elevation will be of reinforced concrete, while the street elevation walls will be of brick.



The building will be steam heated throughout and will be divided above the fourth floor into individual storage rooms of about 50 square feet in area and will be served by four elevators. There will also be ten cold storage vaults, each about 22 x 76 in area.

Exterior stone work as shown in the architect's drawing will be cut cast stone.

New Products Plant Opens in South

Plans have been made for the immediate construction of a plant for the Muscle Shoals Cement Product Corporation at Sheffield, Alabama. It is estimated that plant operation will begin with 25 to 40 men, with a gradual increase in labor as the output grows.

W. J. Runyon, paving company head, is the president of the new concern, Mayor W. S. Eastep, of Florence, Alabama, is vice-president, and O. P. Green, head of the Muscle Shoals Supply Company, is secretary and treasurer.

With the Manufacturers

INDUSTRIAL LITERATURE

Lime Booklet on Mortar

"The Fallacy of Unnecessary Strength," a 16-page 6x9 inch bulletin printed in two colors throughout, is the title of a new bulletin issued by the *National Lime Association,* Washington, D. C. It shows by illustration, statistics and text the cost of using good materials in the wrong places, using mortars as the basis for the discussion. An appendix contains tables showing the compressive strength of clay brick wallettes and sand-lime brick wallettes.

Catalog at Road Show

Chief among the literature distributed by the *Butler Bin Company,* Waukesha, Wis., at its booth at the Chicago Road Show was a new 68-page catalog devoted to steel loading bins and aggregate measuring hoppers. It is quite complete in detail, profusely illustrated, and shows typical yard layouts and methods of handling coarse and fine aggregate.

Hardener Literature

Dycrome, a surface treatment for hardening concrete floors and producing cloud-like effects, is announced by the *Master Builders Company,* Cleveland, Ohio, as the latest addition to the family of Masterbuilt floors, in a letter enclosing a specification and color sheet. The *Dycrome* treatment is applied to any clean cement floor, wall or surface free from foreign matter.

Colors produced include Flemish oak, palmetto green, Nile green, Cordovan, weathered bronze, jade and duo-tone effects in which these colors are combined.

Universal Strengths

How *Universal* portland cement will attain high early strength in three days by a simple procedure is narrated by an 8-page booklet published by the Universal Portland Cement Company. Illustrations showing various scenes of completed concrete opened in three days are followed by directions for doing similar work.

Road Show Leaflet

Plans for the *Second Annual Southwest Road Show and School,* to be held February 22nd to 25th, at Wichita, Kansas, are announced in a broadside and a leaflet issued by the *Wichita Thresher and Tractor Club.* The activities of more than nine southwestern states will be embraced in the road school and the exposition.

"Agrabatcher" Featured

A new catalog published by the Heltzel Steel Form & Iron Company, Warren, Ohio, contains, especially, details on its "One-Man Agrabatcher," for products plants. A single man, by operating one lever, performs the complete operation of filling, cutting off, dumping the batch of sand and stone, closing the lower and opening the upper gates in less than 10 seconds, and the bins may be divided into individual units by a simple change.

Exposition Booklet

The management of the Architectural and Allied Arts Exposition, to be held in the Grand Central Palace in New York City, February 21 to March 5, has distributed an elaborate 16-page, 9 x 12-inch publication, naming the committees in charge and their members, and illustrating exposition space available.

New Books

Complete Book on Structural Formwork

Design and Construction of Formwork for Concrete Structures, by A. E. Wynn, B.Sc., A.M.Am.S.C.E., contains 320 pages of complete designs for formwork. The first of the twenty-one chapters deals with form building in general, followed by others on materials, loads, pressures and stresses, theoretical design of forms, design tables. All manner of structural formwork is included, accompanied by tables from which the size and quantity of timber required for any job may be seen at a glance.

Two hundred and nineteen illustrations, as extensive as the text, are shown.

Published by Concrete Publications, Limited, 20 Dartmouth Street, Westminster, London, England.

NOTES FROM THE FIELD

LeRoi Absorbs Beaver

The *LeRoi Company,* Milwaukee, Wisconsin, has taken over the business formerly conducted by the *Beaver Manufacturing Company,* also of Milwaukee, and makers of *Beaver* gasoline engines. With the addition of this line of engines, the *LeRoi Company* will now manufacture engines ranging in horsepower from 3 to 160.

The *Beaver* engines are intended solely for extremely heavy duty and will have a horsepower range of 40 to 160, and 4 to 6 cylinders.

Ryerson Buys Warehouse

Joseph T. Ryerson and Son, Inc., Chicago, have purchased the warehouse division and property of the *Bourne-Fuller* Company at Cleveland.

Fred S. Doran has been appointed manager. He has been associated with the firm for 21 years.

Konset Goes South

What is considered the first order of its kind, according to F. Daly Sullivan, president of the *Sullivan Company,* of Memphis and Montreal, was a wire requisition from the city of West Palm Beach, Fla., for a carload of *Konset* accelerator. This was ordered for use on the Dixie Highway and city streets in that city.

Rex Manager

F. C. Wilcox, who for 18 years was president of the Foote Concrete Machinery Company of Chicago, Illinois, has joined the *Chain Belt* organization in the capacity of eastern manager of Rex paver sales.

Mr. Wilcox has the distinction of selling the first "continuous paver," which was built in 1903, to the Barber Asphalt Paving Company. He also handled the Foote national advertising for the past 20 years.

Central West Distributors

The Lakewood Engineering Company announces the appointment of the Superior Supply Company, Webster Building, Chicago, distributors of their equipment in the River Counties of Iowa, Northern Illinois, and the northwest portion of Indiana.

Mr. A. N. Herrick, manager of the Chicago office now closed, continues as district supervisor for the central west territory.

Announcement is made of the change of the name of the National Engineering Corporation to Barrows and Company, 40 Central Street, Boston, Mass.

New Equipment

"Mystery Bin" Is Twin Type, Large Capacity Bin; Furnished With Adjusting Device

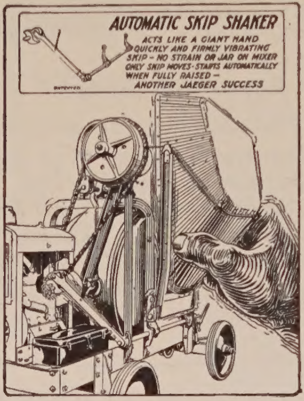
The Heltzel "Mystery Bin" has been made available for public inspection and a wide variety and arrangement of new features has been disclosed. The construction of the bin in general consists of 80 and 105 ton bins cut squarely in the middle on a perpendicular line, each half having its own trailer wheels.

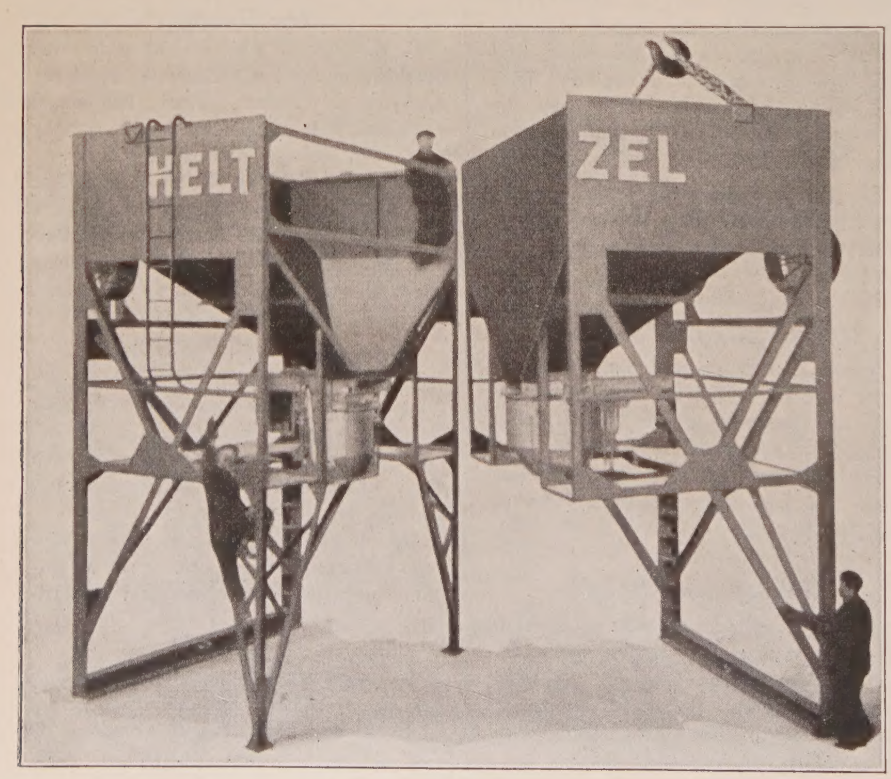
In erecting, temporary legs are fastened to one of the halves and it is stood upright with a crane. The other half is then lifted with a crane and the two halves securely fastened together with 40 bolts. The temporary legs are then removed and the outfit is ready for the first batch. When in trailing position, each half is no larger than a standard 35-ton trailer bin and can be trailed by truck through congested street traffic at from 10 to 20 miles per hour.

An agrabatcher adjusting device has also been designed, to be supplied on order, which consists of a bevel gear set and rear chain and sprocket design; and here, also, the operation of a single control wheel raises or lowers the agrabatcher simultaneously on all four supporting bolts, eliminating the need of operating each one individually by wrench or by hand.

Jaeger Introduces New "Skip Shaker"

Pounding and battering of skips has been overcome by the Jaeger patented "Skip Shaker," which starts to vibrate the hopper when it is fully raised and keeps a continual flow of materials into the mixing drum. The attachment works automatically and easily increases the speed by many more batches a day. This feature is a 1927 improvement made by the Jaeger Machine Co., Columbus, Ohio, on both tilting and non-tilting mixers.


AUTOMATIC SKIP SHAKER
ACTS LIKE A GIANT HAND
QUICKLY AND FIRMLY VIBRATING
SKIP - NO STRAIN OR JAR ON MIXER
ONLY SKIP MOVES - STARTS AUTOMATICALLY
WHEN FULLY RAISED -
ANOTHER JAEGER SUCCESS



Roof Tile With Headlock Feature

A headlock roofing tile having an increased weather stop height and that can be made fast as straight French design tile without headlock is produced by a new machine marketed by the Crawfordsville Machinery Company, Indianapolis, Indiana.

The exposed end of the tile has been decreased a quarter of an inch, to 1⅛ inch, avoiding a top-heavy appearance when laid, while the weather stop height has been increased an eighth inch over other types.

Screed Gauges Eliminate Exposed Steel

All exposed steel on the top or bottom surfaces of concrete slabs and cutting and fitting of wood screeds are eliminated by the use of the adjustable screed gauges. After the gauge is driven into the form, a simple casting is adjusted with a cut nail, holding the casting in place on the gauge.

The gauges may be set with an instrument to obtain absolute accuracy, and do not depend upon the accuracy of the form decking to determine the top or thickness of the slab. The screed or straight edge is zigzagged across the Tee bars and can easily pass by the extension of the gauge above the slab. These gauges may be used and re-used, and are one of the products of the M & M Wire Clamp Company, Minneapolis, Minn.

Feather-Stone "Sixteen" Is New Admixture

For improving the flowability of concrete, Feather-stone "Sixteen" has been found useful. This is a special grade of carefully processed diatomite (a plastic form of finely divided colloidal silica). It is capable of absorbing and holding many times its weight in water, forming a creamy lubricant. Feather-stone "Sixteen" is said also to increase density, strength, and uniformity, and is manufactured by the Feather-stone Insulation Company of Los Angeles, Calif.

Correction

An error occurred in a statement regarding the Ahlers strength regulator appearing on this page last month. The sentence, "Any number of old or broken bags is placed in the cement hopper" should have read, "Any number of odd or fractional bags is placed in the cement hopper."

New Equipment

Knickerbocker Announces New Year Mixer, for Use with New Specifications

The Knickerbocker Company, Jackson, Mich., mixer manufacturers, announce the advent of the New Knickerbocker. This mixer has been designed to enable the contractor to follow latest mixing specifications that require less water to the batch and one and a half minutes mixing time.

In the 1927 7-S the diameter of the drum has been increased to 50 inches, allowing a 22½-inch opening on the charging side and a 20-inch opening on the discharge side. A watertight drum has been secured by welding the head to a steel shaft of 3/16 in. thick. The shape and position of the discharge chute during mixing has the effect of throwing the batch back to the mixing blades for remixing at every revolution, or 20 times per minute.

The wide, semi-round discharge chute is made possible by the increased drum opening and achieves speedy discharge. Nine large buckets are placed on the discharge side and 5 on the charging side. Bevel gears actuated by a hand wheel from either side of the mixer have been substituted for levers. The discharge chute automatically locks in either discharge or mixing position and is automatically released.

The increased heavier frame of the 7-S is built of 7-inch steel channels arc welded and reinforced with steel gussets. Split bearings have been given the countershaft.

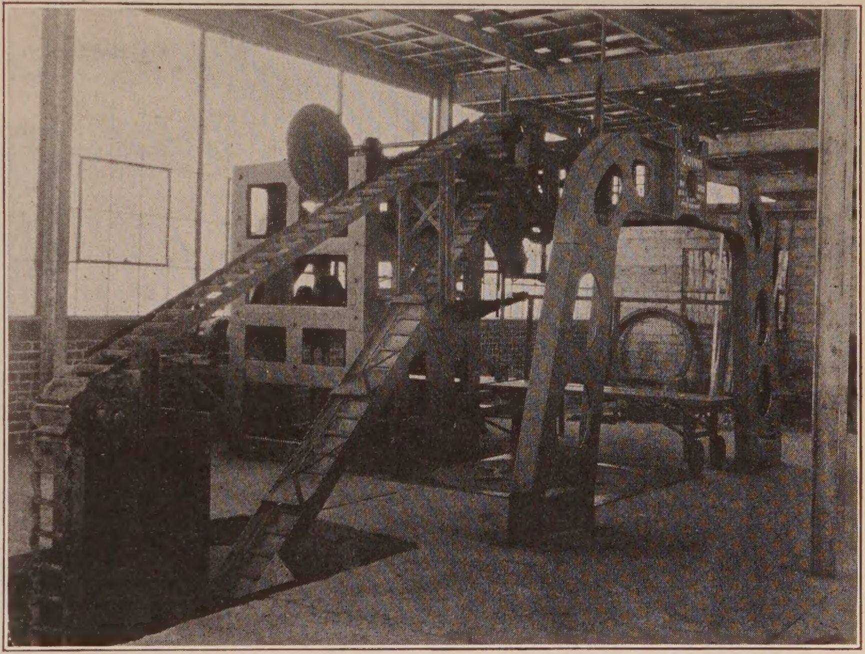
Power is supplied on the 7-S by an 8-hp. 4-cylinder radiator-cooled LeRoi gas engine or a 5-hp. electric motor. The 10-S also may be furnished with an 8-hp. steam engine, without boiler.

The power loader is of the pivot type on heavy malleable pivot brackets, and is raised with two ⅜-inch steel cables. The loader is designed to be quickly attached or removed. The trunnion roll faces are chilled and ground to insure long life and reduce frictional wear on the rolls and drum tracks. They are keyed to the shafts, which are run in babbitted bearings. All shafts are finished, turned, ground, and polished cold rolled steel and are babbitted with the best grade of metal. The trucks are of the 3 point suspension type with 7-inch channels. The length overall is 113 inches and the width 63 inches.

The batch hopper on the 7-S has the same capacity as the drum. It is built of No. 12 gauge steel plate, reinforced at the top edge and supported by a heavy steel frame. The hopper has a 47-degree slope and is equipped with a trip gate operated by a lever.

New Heavy-Duty Pipe Machine Presents Many Improvements

A new heavy-duty pipe machine has just been introduced by the Quinn Wire and Iron Works, Boone, Iowa. The frame is of heavy cast iron, rigidly and sturdily constructed, all bearings are Timken roller type, sprockets are steel cut, and roller chains for driving are unusually heavy. The total weight of the machine is about eleven tons, so that it will turn out more work with no vibration. Pipe lengths of 3, 4, 5 or 6 feet and diameters of from 24 to 54 inches are possible, with either a tongue and groove or bell end.



When in operation the empty mold is placed on the table, and the concrete having been discharged in the hopper of the elevator, the machine is ready to start. The twin tamper bars are dropped within 2 inches of the bottom of the mold, the table is started revolving by bringing the starting lever half way around, while the elevator then starts discharging a continuous stream of concrete into the revolving mold. The starting lever is then brought clear around, starting the tampers working. The tampers continue to pack the concrete with 350 strokes a minute until the material is hard enough to overcome the friction on the tamper bars.

When the top is reached, the tampers are stopped, but the concrete is allowed to pile up against the inside form, where it is trowelled to a cone shape, after which the elevator is stopped. The tongue header is then placed on top of the mold and the tampers brought in motion again to tamp the header down to place, forming the tongue of the pipe. The pipe swings on the cart and is wheeled to the electric hoist where the inside core is collapsed and removed. The header is removed and the finished pipe is ready to be cured.

Jackets are removed from the pipe upon reaching the curing room, while the pipe is on the floor, and a pallet is dropped in place at the bottom of the mold. The mold is picked up by the cart and wheeled under the electric hoist. A wire reinforcing cage is dropped into the mold, the electric hoist lowers the inner core and the mold is ready for another operation of the machine.

Bell end pipe is made with the same operations, with the exception that after the mold has been placed on the table and the machine started, a jolting or jarring mechanism is thrown in place by a hand lever, which jolts the plate rapidly as it revolves, packing the material in the bell part, after which the lever is thrown back and the tampers started tamping the bell to a greater density.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

"Cement" Bill

There is a feller in our town
That folks call "Cement Bill."
Some folks even go so far
As to call him "Cement Will."
But that sounds kind o' mushy like,
No punch or kick or thrill.
In fact, you have to use concrete,
Describing "Cement Bill."

This "Cement Bill" extols cement
Until you want to weep,
He sings cement an' prays cement
An' talks it in his sleep.
"Bill," he sez, "take cement posts,
Now ain't they spruce and neat?
Why grapes trained up on cement posts
Grow twice as big and sweet."

"An' last, why mister, bless your soul,
I'll give my guarantee
That cement posts, when made first class,
Outlast eternity.
Exaggerate! Oh, no, not I,
I simply state what's true.
Exaggerate cement you say—
A thing no man can do."

"For when you want a first-class job
An' see your cash well spent,
You naturally got to 'own the coin,'
There's nothing like cement."
Why "Cement Bill" he sez, sez he,
"Cement be-gosh will float,
I know it will, because," sez he,
"Folks built a cement boat."

An' Cement Bill he sez, sez he,
"You may think I'm a liar,
But barns built out of cement block
Will stand the hottest fire.
An' look at all the fireproof homes—
Cement in every style—
Why even bridges, crossing streams,
Are built on cement pile."

"Then think of all the cement roads—
Why, man, they set the pace—
They ride so smooth, no jars or bumps
An' say, they eat up space.
Now there's the cement silo, too—
The silo built of wood,
Takes lots of paint, an' soon blows down,
Where cement never could."

Sez Cement Bill, "When I pass out,
Bound for my last abode,
I want the boys to drive me down
A first-class cement road.
I want my little two by six
Lined with good cement,
So devils cannot fork me out,
Nor hell fire make a dent."

"When Gabriel comes to rout me out
An' calls for my ascent,
I want to know he'll find me there,
Embedded in cement.
Then when I'm wafted to that place
Of mansions in the sky,
If they ain't built of cement block,
I'll ask the reason why."

—Gen. A. R. Benson,
Ex-Secretary of State of Delaware.

(THIS IS CONTRIBUTORS' MONTH)
Joe, the Mixer Boss.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City.

American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference: H. E. Plummer, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago. Third annual meeting, Greenbrier Hotel, White Sulphur Springs, W. Va., March 21-23.

Concrete Products Association; John E. Powers, President, Sterling, Ill.; D. R. Collins, Secretary, 47th and State Streets Alois postoffice, Milwaukee, Wis.

Concrete Products Association of Greater Boston; Glenn T. Hoyt, Secretary, 80 Whitman Ave., Melrose, Massachusetts.

Iowa Concrete Products Association; H. E. Meier, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President, 37th St. & Stewart Ave., Chicago. A. W. Dickson, Executive Secretary, 214 Electric Bldg., Cleveland, Ohio.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

The National Lime Association: Burton A. Ford, Secretary, 927 15th Street, N. W., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

National Sand and Gravel Association, V. P. Ahearn, Executive Secretary, 432 Munsey Bldg., Washington, D. C.

Nebraska Concrete Products Association; A. V. Anderson, President, Reimers-Kaufman Co., Lincoln, Neb.; E. L. Bateman, Acting Secretary, Bethany, Neb.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Wisconsin Concrete Products Association; A. P. Kuranz, Secretary-Treasurer, 425 E. Water St., Milwaukee.